INTEGRATING LOCAL AND TRADITIONAL KNOWLEDGE AND HISTORICAL SOURCES TO CHARACTERIZE RUN TIMING AND ABUNDANCE OF EULACHON IN THE CHILKAT AND CHILKOOT RIVERS

By

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Abstract

Eulachon smelt *Thaleichthys pacificus* are anadromous forage fish of the North Pacific Ocean that annually spawn in coastal rivers of North America in late winter and early spring. These spawning runs range from northern California to southwestern Alaska and provide important resources to nearby communities, indigenous cultures, and wildlife predators. However, eulachon life history is not well understood or documented throughout their range. In recent years, concerns for eulachon population abundances in the southern portions of their range have led to federal protection. Though there are no federal listings in Alaska, there have been local concerns documented for eulachon runs of the Chilkat and Chilkoot rivers since approximately 1990. However, eulachon run timing and abundance trends are difficult to detect due to limited available data and variability in eulachon runs. To document baseline information and explore patterns of eulachon runs of the Chilkat and Chilkoot rivers, we sought local and traditional knowledge from residents of nearby communities to document information about local uses, run timing, abundance, and wildlife observations related to eulachon runs. Observations of eulachon runs were integrated with historical records from newspaper articles and scientific reports to construct temporal trends in eulachon run timing and abundance.

Based on the findings of this study, annual eulachon runs of the Chilkat and Chilkoot rivers generally occur for about a week or two between mid-April and mid-May. The arrival dates of eulachon runs often vary from year to year, but the timing appears to have shifted earlier, from mid-May to mid-April, over the past couple of decades. Abundance records were not sufficient to quantify trends. However, qualitative information regarding abundance did not suggest any clear trends in eulachon abundances of the Chilkat and Chilkoot rivers over the years, nor did there appear to be prominent local concerns about abundance declines. Many respondents suggested that eulachon populations were naturally too variable to be able to describe trends in abundance. Interviews also provided insight into local perspectives on eulachon life history and ecology. These results suggest that variability in eulachon run timing and abundance could be related to environmental conditions, including tidal height, river habitat, and water temperature. For a data-limited species like eulachon, integrating local observations and historical records offers a promising approach to documenting baseline information and improving the scientific understanding of eulachon runs and other environmental phenomena.

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1 Introduction

Eulachon *Thaleichthys pacificus* (Richardson 1836) are anadromous forage fish of the smelt family Osmeridae (Mecklenburg et al. 2002). They inhabit the northeastern Pacific Ocean and annually spawn in coastal rivers ranging from northern California (Odemar 1964) to southwestern Alaska (Hart 1973). Eulachon typically migrate upriver in dense and abundant aggregations to spawn over a short time period, occurring as early as December in southern regions and as late as June in northern regions (Willson et al. 2006; Gustafson et al. 2010). These spawning events, referred to as eulachon runs or returns, provide important resources to local communities, indigenous cultures, and wildlife throughout their range.

1.1 Cultural and ecological significance of eulachon

The name "eulachon" is recognized by the American Fisheries Society as the official common name and spelling (Mecklenburg et al. 2002; Nelson et al. 2004). This name originated as jargon from the Chinook Indian trade language (Hart and McHugh 1944; Gustafson et al. 2010; Moody and Pitcher 2010) and now includes many variations in spelling and pronunciation that are commonly used to refer to eulachon throughout their range, including hooligan, oolichan, and ooligan (Hart and McHugh 1944; Moody and Pitcher 2010). The scientific name, *Thaleichthys pacificus*, means "rich or oily fish of the Pacific Ocean" (Hart 1973) and refers to the notably high oil content of eulachon (Payne et al. 1999). Eulachon are also known to some as "candlefish" because the high oil content allows a dried eulachon to burn like a candle (Swan 1880; Hart 1973). Other names used to refer to eulachon include smelt, Columbia River smelt, fathom fish, small or little fish, and savior fish (Hart and McHugh 1944; Gustafson et al. 2010).

Eulachon runs are culturally, economically, and nutritionally important to indigenous groups along the North American Pacific coast. They have been deemed as the "salvation" fish for providing indigenous communities a reliable food source after winter, a time when starvation was historically a risk (Moody and Pitcher 2010). Many indigenous groups value eulachon for their oil, also known as grease, which is rendered from fermented fish through a generalized process of harvesting, fermenting, and cooking eulachon to release and collect oil (Harrington 1967; Betts 1994). The oil is used for a variety of consumptive and medicinal purposes, including as a condiment on foods, for preserving berries, and consuming daily as a dietary

supplement (Betts 1994). Eulachon oil is also highly valued as a trade item, and trade routes linking coastal interior communities became known as "grease trails" for the notable exchange of eulachon oil (Collison 1941; Moody and Pitcher 2010). Eulachon remain valuable to many indigenous cultures, and many non-indigenous residents of local communities near spawning rivers also participate in eulachon harvests for subsistence and other activities, including photography and observations of wildlife activity.

Eulachon have been documented as prey for many wildlife types and species, including multiple species of fish, birds, marine mammals, and land mammals (Willson et al. 2006). The annual timing of eulachon runs in late winter and early spring provides wildlife a reliable food source when few or no other prey are available (Willson et al. 1998). Additionally, the high oil content of eulachon makes them a nutritious food source (Kuhnlein et al. 1996; Sigler et al. 2004). Aggregations of predators, especially birds and sea lions, appear near the mouths of rivers when eulachon are spawning, and some marine mammals, such as sea lions, follow eulachon up into the rivers (Marston et al. 2002; Willson et al. 2006). The appearance of abundant wildlife in an area is often a sign to local peoples that eulachon runs have arrived in nearby rivers (Willson et al. 2006).

1.2 Research need

In recent decades, eulachon populations have gained increasing attention, especially in the southern regions of the species range. In 2007, the Cowlitz Indian Tribe petitioned the National Marine Fisheries Service (NMFS) to list eulachon under the Endangered Species Act (Cowlitz Indian Tribe 2007); in May 2010, the southern Distinct Population Segment (DPS) of California, Oregon, and Washington was listed as "threatened" under the Endangered Species Act (NMFS 2011). In May 2011, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) listed three British Columbia populations for protection: the Central Pacific Coast Population as "endangered," the Fraser River Population as "endangered," and the Nass/Skeena River Population as "threatened" with its status lowered to "special concern" in May 2013 (COSEWIC 2011, 2013). Eulachon are known to spawn in at least thirty-five rivers in Alaska (Moffitt et al. 2002); however, there are limited scientific data on Alaskan eulachon population abundances. In northern Southeast Alaska, some local residents have expressed concern for eulachon runs of the Chilkat and Chilkoot rivers since approximately 1990 (Betts 1994). Though

the Alaska Department of Fish and Game (ADFG) has published some ethnographic reports that documented eulachon subsistence of the Chilkat and Chilkoot rivers (Mills 1982; Magdanz 1988; Betts 1994; Turek 2009), there are no management activities currently implemented to regularly document harvest activity or monitor these populations.

Although eulachon abundances appear to be declining in some rivers throughout their range, monitoring and managing these populations are difficult without proper understanding and documentation of eulachon life history. Because the species is not commercially important, limited resources are available for life history studies. Scientific studies have been conducted to address information gaps (Hay and McCarter 2000; Gustafson et al. 2010; COSEWIC 2011), but there still remains insufficient published research and scientific data to address many ecological questions pertaining to eulachon.

1.3 Eulachon life history

Mature eulachon spend most of their life cycle in the marine environment before returning to freshwater streams to spawn (Hay and McCarter 2000; Willson et al. 2006; Moody and Pitcher 2010). Although eulachon are thought to typically be semelparous (spawning once in their lifetime), cases of iteroparity have been documented (Willson et al. 2006). Mature eulachon have elongate silver bodies, with a white underbelly and a brown or dark blue speckled back (Scott and Crossman 1973). Spawning males are generally larger in size than females, with longer pelvic fins and a rough texture of the body due to nuptial tubercles on the scales (Willson et al. 2006; Moody and Pitcher 2010). Eulachon generally spawn between two and five years of age, but one spawning run could contain eulachon of various ages (Willson et al. 2006).

Eulachon return to rivers to spawn, though the extent to which they home to their natal river is not well understood (Hay and McCarter 2000; Flannery et al. 2013). Some recent genetic studies suggest that eulachon may home to a broader area but not necessarily to a specific river (Flannery et al. 2013; Candy et al. 2015). Documented spawning rivers vary in physical conditions, but all are fed by a spring freshet (Hay and McCarter 2000; Gustafson et al. 2010). Eulachon can assimilate pollutants (Rogers et al. 1990) and may show river avoidance if the water is polluted (Smith and Saalfeld 1955). The spawning site within a river may also vary among years, and the spawning reaches between different rivers may be influenced by environmental factors such as tides, river gradient, and water temperature (Lewis et al. 2002;

Brock and Coiley-Kenner 2009). Eulachon spawn in different types of substrate, including silt, sand, gravel, cobble, and detritus, though sand and gravel seem to be the most common (Willson et al. 2006; Moody and Pitcher 2010). Viable sperm may only last outside the male for minutes, and partners must closely synchronize spawning, which appears to occur at night (Parente and Snyder 1970; Hay and McCarter 2000).

Eulachon spawn in late winter and early spring, and eulachon in southern regions generally spawn earlier than eulachon in northern regions (Hay and McCarter 2000; Willson et al. 2006; Gustafson et al. 2010). In rivers of California and the Columbia River basin, eulachon spawn as early as January or February, whereas runs in Alaska often do not occur until April or May (Hay and McCarter 2000; Willson et al. 2006; Gustafson et al. 2010) though some rivers have a smaller, sporadic winter run earlier in the year (Betts 1994; Gustafson et al. 2010). Multiple runs demonstrate annual variation in run timing and abundances within river systems, though some runs are fairly reliable (Willson et al. 2006). Eulachon run timing may be related to high tides and river temperature (Ricker et al. 1954; Spangler 2002), though the reasons for variations are not well understood.

1.4 Local and traditional knowledge of eulachon

The documentation of local and traditional knowledge (LTK) offers a promising approach to recording baseline information and improving the overall understanding of many environmental phenomena (Huntington et al. 2004; Failing et al. 2007), including eulachon runs. In this study, LTK is defined as knowledge accumulated over time and comprised of the observations, understandings, and expertise of local residents and indigenous peoples of an area (Berkes et al. 2000; Gilchrist et al. 2005; Thornton and Scheer 2012). This type of information, which is known by many terms and definitions, has been increasingly recognized for its value in informing the research and management of many data-limited species by providing historical information that may not otherwise be available (Betts 1994; Moody and Pitcher 2010; Taylor et al. 2011; Beaudreau and Levin 2014; Ryan 2014). An often-used term is "traditional ecological knowledge" (TEK), which is commonly defined as an evolving body of cultural knowledge transmitted through generations and often held within a community or culture (Berkes et al. 2000). Local knowledge, however, generally refers to knowledge accumulated from individual experiences, often at a local scale and within a shorter time period, that may be shared with other

people (Gilchrist et al. 2005; Zukowski et al. 2011). For the purposes of this study, both types of knowledge contribute valuable information to eulachon life history and are collectively defined as LTK.

Many agencies, tribes, and researchers are now documenting LTK of eulachon and other cultural resources, and this information is becoming available for widespread reference through published reports. The ADFG Division of Subsistence publishes a series of ethnographic and harvest reports that often document LTK of traditionally important species in Alaska (Mills 1982; Magdanz 1988; Betts 1994). In 1990 and 1991, an ADFG ethnographic study of eulachon of the Chilkat and Chilkoot rivers documented eulachon subsistence in response to local concerns for the eulachon runs (Betts 1994). Megan Moody of the University of British Columbia conducted her Master's thesis on past and present eulachon runs, including documenting traditional knowledge to estimate harvests and abundances in British Columbia (Moody 2008). Reynolds and Romano (2013) interviewed Cowlitz Tribal elders and non-tribal elders to record oral histories related to eulachon fishing, run timing, and spawning distribution in the lower Columbia River region. Teresa Ryan of the University of British Columbia utilized traditional knowledge in her doctoral research, with a focus on cultural and economic significance of eulachon in British Columbia (Ryan 2014). LTK may further assist in understanding eulachon life history characteristics, including documenting historical and contemporary trends of eulachon run populations.

Through direct observation of and interaction with eulachon runs, local residents of communities near eulachon runs are presumed to have knowledge that may otherwise be undocumented. By documenting LTK from interviews with local residents, information can be synthesized, corroborated, and integrated with available historical records and scientific data to detect trends and explore temporal changes in eulachon runs. This information can be used to help establish baseline information and understand causes of unexplained variation in run timing and abundance throughout the species range.

1.5 Study area

This study focuses on eulachon from the Chilkat and Chilkoot rivers of northern Southeast Alaska (Figure 1). In these rivers, eulachon generally spawn in late April and early

May (Betts 1994), supporting harvests and oil rendering by local and Tlingit indigenous residents of the nearby communities of Haines and Klukwan.

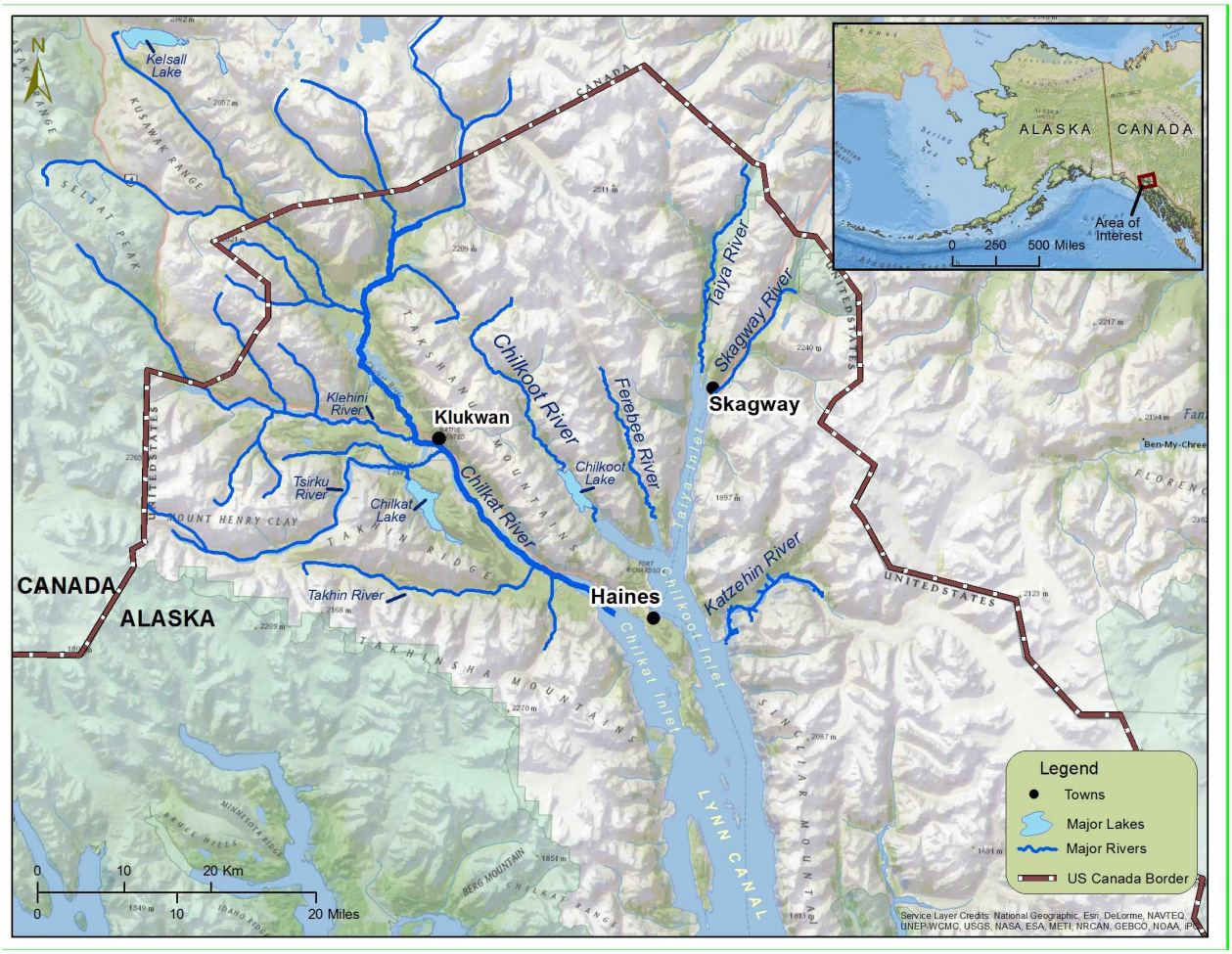

Figure 1: Area map of the Chilkat and Chilkoot rivers. The study area includes the lower reaches of the Chilkat and Chilkoot rivers and the nearby communities of Haines and Klukwan. Courtesy of Alaska Department of Fish and Game.

The Chilkat and Chilkoot rivers both originate in Canada and respectively flow into Chilkat Inlet and Lutak (Chilkoot) Inlet of northern Lynn Canal, Alaska (Betts 1994; Bachman 2005). Nearby are the communities of Haines and Klukwan in the traditional territory of the Chilkat and Chilkoot Tlingit peoples (Betts 1994). The study area includes the lower reaches of the Chilkat and Chilkoot rivers where eulachon harvests occur primarily by local residents of Haines and Klukwan. Hereafter, this study area is referred to as the Chilkat-Chilkoot area.

The Chilkat River is a large glacial system that originates in Canada and flows southeast for approximately 64 kilometers (39.8 miles) until its terminus in Chilkat Inlet near Haines and

Klukwan, Alaska (Betts 1994; Bachman 2005; Ericksen and Fleischman 2006). The mouth of the Chilkat River is approximately 3.6 kilometers wide (Ryan 2012), and the first 14.5 kilometers (9 miles) are characterized by many turbid, braided channels that regularly change (Betts 1994; Bachman 2005; Ryan 2012).

The Chilkoot River is a glacial river that terminates in Chilkoot Inlet approximately 11.3 kilometers (seven miles) north of Haines (Sowa 2015). The Chilkoot River flows approximately 32.2 kilometers (twenty miles) from its origination to Chilkoot Lake, which is four kilometers (2.5 miles) long and 1.6 kilometers (one mile) wide (Sowa 2015). The lower Chilkoot River flows approximately 2.7 kilometers (1.7 miles) from Chilkoot Lake into Lutak and Chilkoot Inlet (Sowa 2015). In contrast to the Chilkat River, the Chilkoot River is single-channeled and transparent (low turbidity) in the lower reaches below Chilkoot Lake (Betts 1994; Ryan 2012). Other nearby rivers in Lynn Canal that support or have supported eulachon runs include the Taiya River near Skagway (Bishop 1989; Betts 1994), the Ferebee River at Taiyasanka Harbor, and the Berners and Lace rivers in Berners Bay (Betts 1994); however, fewer people live near or harvest eulachon from these rivers, thus limiting the opportunity for LTK outside of the Chilkat and Chilkoot rivers.

There are two Tlingit tribes in the Chilkat-Chilkoot area, the Chilkoot Indian Tribe in Haines and the Chilkat Indian Village in Klukwan. The community of Haines is the contemporary home of the Chilkoot Tlingit. In 2010, Haines had a population of 1,713 individuals; 16.2% of residents identified as American Indian or Alaska Native, either alone or in combination with another race (United States Census Bureau 2010). The Haines Highway connects Haines and Klukwan, following the north bank of the Chilkat River (Betts 1994). Klukwan is home to the Chilkat Tlingit and is located along the Chilkat River 35.4 kilometers (22 miles) north of Haines. In 2010, Klukwan had a population of 95 individuals; 90.5 % of residents identified as American Indian or Alaska Native, either alone or in combination with another race (United States Census Bureau 2010).

1.6 Research objectives

This study aimed to characterize eulachon runs of the Chilkat and Chilkoot rivers with an emphasis on understanding temporal patterns in run timing and abundance. LTK was also documented and integrated with historical records and scientific knowledge to document and

identify trends in eulachon run timing and abundance, guided by the following working hypotheses:

Hypothesis 1: Eulachon run timing of the Chilkat-Chilkoot area is shifting earlier over time.

Eulachon run timing is known to be variable among years and between rivers. This variability and the lack of data make run timing trends difficult to assess. However, some eulachon systems have shown reportedly earlier runs in recent years (Joyce et al. 2004; Moody and Pitcher 2010), possibly linked to changes in river and estuary temperatures (Ricker et al. 1954; Moody and Pitcher 2010). Many populations of other anadromous species (Pacific salmon, *Oncorhynchus* spp.) have demonstrated earlier run timing in Southeast Alaska as well (Kovach et al. 2015). Due to changes in climate and potential effects on run timing (Willson et al. 2006), eulachon runs of the Chilkat-Chilkoot area are hypothesized to be occurring earlier over time than historically.

Hypothesis 2: Timing of eulachon river entry of the Chilkat River differs from the Chilkoot River.

The Chilkat and Chilkoot rivers are spatially close and flow into the same estuary, and eulachon runs are regularly observed in both rivers in a given year (Betts 1994). Based on discussions with local residents, eulachon runs of both rivers occur during the same time of year. However, local residents have noted that eulachon migrate up the Chilkat River earlier than they migrate up the Chilkoot River (Betts 1994), suggesting that the start date of the eulachon run may be different between the Chilkat River and Chilkoot River in a given year.

Hypothesis 3: Eulachon abundance in the Chilkat-Chilkoot area is declining.

Eulachon populations and concerns for declines have gained increasing attention in recent years, particularly in the southern regions of the species range (NMFS 2011; COSEWIC 2011). Due to local concerns for eulachon runs of the Chilkat and Chilkoot rivers in the early 1990s (Betts 1994) and recent federal listings of southern eulachon

populations (NMFS 2011; COSEWIC 2011), eulachon abundances of the Chilkat and Chilkoot rivers are hypothesized to be declining.

1.7 Thesis outline

This thesis is organized into seven chapters. In this chapter, background information was provided on eulachon runs, the study area, and the importance of this research. In Chapter 2, the methods are described, including the research approach, the information sources, and the steps used to collect and analyze information. Chapters 3, 4, and 5 describe the results of this study including integrating LTK obtained in this study with previously documented observations. Chapter 3 provides an overview of the historical and contemporary importance of eulachon in the Chilkat and Chilkoot rivers, including the Tlingit culture and the forms of participation that local residents engage in surrounding eulachon runs. In Chapter 4, eulachon run timing and abundance in the Chilkat and Chilkoot rivers are discussed. This includes indicators of eulachon runs, LTK of run timing and abundance variation, and an integration of information sources and records to construct temporal trends. Additional information acquired through interviews is discussed in Chapter 5, which describes LTK about eulachon life history and ecology in the context of eulachon runs of the Chilkat and Chilkoot rivers. Chapter 6 concludes this research with a review of the main findings, reflection on the methods, and implications of the results. All references cited within the thesis are listed in Chapter 7.

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2 Information sources and interview methods

The research design of this study consisted of 1) documenting local and traditional knowledge to characterize eulachon runs of the Chilkat and Chilkoot rivers; and 2) using triangulation (Jick 1979; Nursey-Bray 2006) to integrate LTK with other information sources. As a technique in qualitative research, triangulation is used to reduce bias through corroborating information from multiple perspectives, such as multiple data sources, researchers, theories, or methodologies (Jick 1979; Nursey-Bray 2006). In this study, we first employed triangulation by corroborating LTK from multiple respondents, which increases the confidence in the conclusions that can be drawn from this information. We then integrated LTK with historical records collected from newspaper articles, ethnographic literature, and scientific studies to construct and describe temporal trends in run timing and abundance of eulachon.

2.1 Semi-structured interviews

We documented LTK about eulachon runs of the Chilkat and Chilkoot rivers from interviews with twenty respondents in Juneau, Haines, and Klukwan. We implemented an interview protocol (Appendix A) that was organized into four main sections, including respondent experience with eulachon, observations of eulachon run timing, observations of eulachon abundance, and wildlife observations. The protocol followed a semi-structured interview format (Spradley 1979), which includes specific questions under each topic but is flexible enough to allow respondents to discuss additional topics of interest or importance to them. The lead researcher (Olds) of this study was based in Juneau, Alaska and conducted all interviews in-person.

2.1.1 Community visits

The Tlingit peoples near the Chilkat and Chilkoot rivers have rich cultural ties to the eulachon runs of the area, including a history of rendering oil for consumption and trade with other communities (Betts 1994). Eulachon runs also support harvests and other activities by local residents of the nearby communities, as well as attract various species of wildlife predators (Betts 1994). In addition, the Chilkat and Chilkoot rivers provide logistic and research advantages for documenting LTK of eulachon: travel to and from Haines and Klukwan was

economically and temporally feasible, there were recent scientific research studies and data on eulachon in the area, and historical information on local eulachon runs had been documented in the past (Krause 1956; Mills 1982; Magdanz 1988; Betts 1994).

To become familiar with the study area, the lead researcher made an initial visit to Haines in February 2013. The purpose of this three-day visit was to become familiar with the local communities and rivers, to establish connections with prospective respondents through the assistance of local contacts, and to identify historical information sources by visiting local agencies. A second visit was made to Haines and Klukwan in May 2013 in order to observe and participate in harvests of the annual eulachon run occurring on the Chilkoot River, including learning through participant observation (Bernard 2006). Participation included dip netting, talking with other harvesters, taking photographs, and visiting oil rendering sites along the Chilkat River.

2.1.2 Sampling frame

To document information about eulachon runs of the Chilkat and Chilkoot rivers, we sought LTK from local residents who held knowledge of eulachon runs, particularly in regards to run timing and abundance observations. Because local residents may acquire this type of information through a variety of forms (Beaudreau and Levin 2014), "knowledgeable respondents" were not limited to those identified as local experts on eulachon or individuals with direct experience with eulachon harvests, oil rendering, or other activities.

Respondents were identified through snowball sampling, a non-probability sampling technique where knowledgeable respondents are recommended by other individuals (Bernard 2006). The initial respondents were identified through recommendations from key contacts who lived in or had connections to Haines or Klukwan. From these recommendations, a list of prospective respondents was created for the first group of interviews, which occurred in July 2013 (n = 1 in Juneau) and September 2013 (n = 5 in Haines). Subsequent respondents were identified through snowball sampling, where each respondent was asked to recommend other individuals whom he or she considered knowledgeable about the interview topics and would be potentially willing to participate in an interview. A list of recommended respondents was compiled; those who had received multiple recommendations were identified as key respondents in the communities and contacted first to set up interviews. Prior to conducting interviews, the

lead researcher contacted prospective respondents in-person or through email, letter, or phone to introduce the study and invite them to assist in the research by participating in an interview. Of the respondents who were available, all were willing to participate and were interviewed in November 2013 (n = 7 in Haines and n = 5 in Klukwan).

Eligible respondents included adults who were considered knowledgeable about eulachon runs of the Chilkat or Chilkoot river as identified through recommendations, and, for logistical purposes, lived in or near Klukwan, Haines, or Juneau at the time of the interviews. At the completion of the interviews, respondents completed a demographics form (Appendix B). In total, sixteen individual and two paired interviews were conducted, for a total of eighteen interviews with twenty respondents (Table 1). Of twenty respondents, sixteen self-identified as Tlingit.

Table 1: Respondent demographics. Respondents identified their demographics at the completion of each interview, where n is the number of respondents who indicated each demographic. Two respondents identified themselves as both "American Indian or Alaska Native" and "White."

Demographic		n
Gender	Male	16
	Female	4
Age in 2013	30-39	2
	40-49	2
	50-59	5
	60-69	7
	70-79	3
	80-89	1
Location	Haines	11
	Klukwan	8
	Douglas	1
Ethnicity	American Indian or Alaska Native	15
	White	7

2.1.3 Conducting interviews

Most interviews were conducted at the respondent's place of residence; other locations included the respondent's place of employment, the Haines Borough Public Library, and tribal offices. We encouraged respondents in advance to bring any documentation or materials helpful to recall run timing and abundance observations. Prior to the start of each interview, each respondent agreed to and signed a consent form stating his or her willingness to participate and be audio-recorded (Appendix C); each respondent was given a signed copy of the consent form. All twenty respondents agreed to be audio-recorded, and detailed notes were taken in addition to the audio recording.

The interview protocol followed a semi-structured format and was approved by the University of Alaska Fairbanks Institutional Review Board (Appendix D) and pilot-tested through practice interviews. The protocol format was modified once after the first formal interview in order to improve effectiveness. Questions were unaltered except for the removal of some questions and addition of others; the removed topics were not used in quantitative analyses and the added questions were noted in the protocol.

Each interview began with the respondent being shown two photos of eulachon (Figure 2) and then being asked what he or she calls "this fish"; the name identified by the respondent was then used to refer to eulachon throughout the interview. For example, if a respondent referred to eulachon as "hooligan," the common name "hooligan" was then used in all subsequent questions. The first section of the protocol focused on the types and extent of the respondent's knowledge of Chilkat or Chilkoot River eulachon runs, including the respondent's experiences through harvesting, oil rendering, research, and other activities. The middle two sections of the protocol focused on run timing and abundance, respectively, and the final part of the protocol asked about other species of animals associated with eulachon runs.

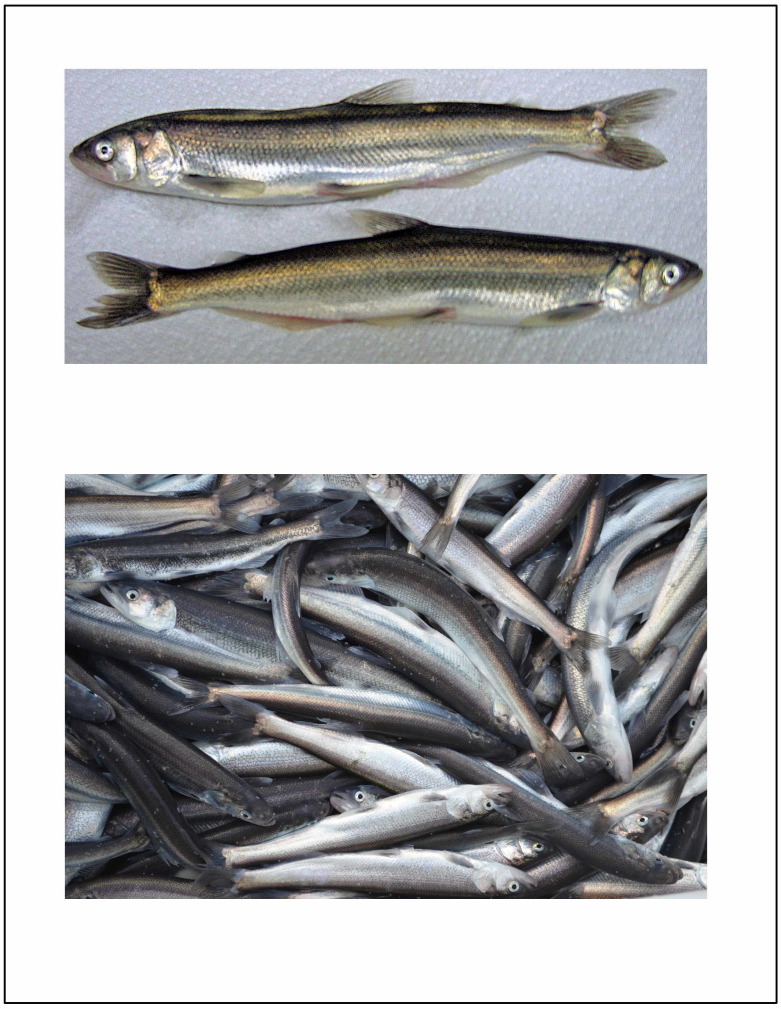

Figure 2. Photos of eulachon. Sources: WikiCommons (top) and Allyson Olds (bottom).

Questions about run timing began with the respondent describing general run timing and then narrowing down to specific observations. During the interview, the respondent was given time to recall and describe all observations, even when the year of an observation was unknown. Questions about abundance also started broad and became more specific, where the respondent first described general observations and patterns and then described specific years. The respondent was then asked to rate the overall abundance of eulachon in each river for every decade that they lived in the Chilkat-Chilkoot area. The respondent was presented a Likert scale (Bernard 2006; Beaudreau and Levin 2014), which is a rating scale that measures a response to a comment or question; the ratings included very low (VL), low (L), medium-low (ML), medium (M), medium-high (MH), high (H), and very high (VH). Each respondent was then asked to describe specific years that eulachon abundance was higher or lower than normal; for years that

the respondent could recall, the same Likert scale was used to rate individual years (see Appendix A, Interview protocol).

In the final protocol section, each respondent participated in a free listing exercise (Bernard 2006), in which the respondent was asked to list any and all animals he or she has ever observed at eulachon runs of the Chilkat and Chilkoot rivers. A blank, lined worksheet (see Appendix A, Interview protocol) for note-taking was provided, and the respondent was given the option to write in the animal names themselves or have the researcher write in the names while the respondent verbally listed animals. The interviewer monitored the exercise and encouraged the respondent to take his or her time and think of all possible answers. Verbal clarification was given, when appropriate, so that respondents would not limit the exercise only to predators of eulachon. Probing was also used when a respondent excluded major animal groups, like fish or marine mammals. When the respondent finished listing animals, the interviewer asked the respondent a second time if there are any other animals he or she has observed. The respondent was then asked to describe his or her observations of each animal from the free listing exercise, such as the behavior or location of the animal. Finally, the respondent was asked a series of four questions to address interactions between or with animal species (note that these four questions were added to the protocol after the first interview).

At the conclusion of each interview, the respondent was asked to recommend other people he or she considered to be knowledgeable about the interview topics and would be willing to participate. Each respondent was designated a unique code to preserve the respondent's anonymity, and no results were linked to the respondent's name. All interviews were digitally audio-recorded using a SONY IC Recorder and imported into Express Scribe by NCH® Software for transcription. Interviews ranged from 12 to 195 minutes, but the majority of interviews were between one and two hours long.

2.1.4 Reducing bias

Bernard (2006) discusses four types of criteria to reduce bias in qualitative research: validity, reliability, accuracy, and precision. Validity refers to the accuracy and trustworthiness of instruments, data, and findings; reliability is based on the credibility of the respondent and the information provided; accuracy refers to the correctness of information; and precision is the level of detail of the information (Bernard 2006). This study implemented these criteria to reduce bias

by gaining rapport with the respondents, ensuring consistency of interviews, and corroborating information through triangulation.

2.2 Secondary sources

Records from secondary sources were integrated with LTK to construct temporal trends in run timing and abundance of eulachon runs of the Chilkat and Chilkoot rivers. Secondary sources included historical records and scientific data collected from an extensive review of published and unpublished documents. During community visits, the lead researcher conducted informal research to identify local sources of historical records, including newspaper articles, artifacts, unpublished documents, and photographs. The Chilkat Valley News, the Haines Borough Public Library, and the Sheldon Museum and Cultural Center were consulted; other sources were identified through online search engines, professional contacts, and literature reviews.

2.2.1 Newspaper articles

Local newspaper articles and their photo captions reported valuable information about eulachon runs in the Chilkat and Chilkoot rivers, including eulachon run timing dates and descriptions of eulachon abundance. The lead researcher identified local sources of newspaper articles during community visits, and these primarily included print newspaper articles archived in boxes at the Haines Borough Public Library. Most articles were from the Chilkat Valley News (CVN), a weekly newspaper published on Thursdays that has served Haines and Klukwan since its establishment in 1966; CVN articles published from 2010 to 2013 were available online through subscription. Lynn Canal News (LCN) articles were also archived at the Haines Borough Public Library, and this newspaper served Haines, Klukwan, and Skagway from 1979 to 1984. One relevant article was also found in the Eagle Eye Journal (EEJ), which served Lynn Canal and the Chilkat Valley from 1997 to 2001. A total of sixty-one relevant articles were identified, including forty-two print articles dated back to the 1970s and nineteen online articles dated between 2010 to 2013.

In November 2013, we conducted a complete manual search of archived print newspaper articles at the Haines Borough Public Library. Based on preliminary research and discussions with local residents, April and May are the general months of the annual eulachon runs in the

Chilkat and Chilkoot rivers. February was also identified to have a winter spawning run on the Chilkat River. Thus, we reviewed all newspapers published between January and June to include all spawning months of eulachon runs, including a one-month buffer before and after.

To conduct a comprehensive yet efficient search, the following steps were used to search through boxes of archived newspapers and identify relevant articles: 1) the print date of each newspaper was reviewed; 2) if the publish date was between January and June, the newspaper was reviewed for articles that mentioned eulachon or appeared potentially relevant; and 3) any articles that mentioned or referenced eulachon were digitally scanned to be thoroughly read at a later time. In May 2014, the lead researcher obtained a one-month online subscription to the CVN to identify relevant electronic newspaper articles, which dated back to 2010. To identify relevant articles, the following common names were searched: eulachon, hooligan, smelt, and saak. Nineteen relevant articles were downloaded and electronically stored.

Each relevant newspaper article was read, and an electronic tool was used to highlight records of run timing, abundance, and wildlife observations. Each article was labeled in a spreadsheet database (Microsoft Excel 2011; hereafter referred to as "Excel") by newspaper date and agency. Each individual observation was identified by newspaper date and agency and summarized within the database. Records were then organized and labeled by the following topic(s) that applied: run timing, abundance, and wildlife. A total of 167 reports of run timing, abundance, and wildlife were identified from newspaper reviews (Appendix E)

2.2.2 Published studies and reports

A review of historical, ethnographic, and scientific literature provided pertinent qualitative and quantitative information about run timing and abundance of eulachon in the Chilkat and Chilkoot rivers. Published literature was identified through online search engines, library resources, literature citations, and professional contacts. Professional contacts were also consulted to locate additional unpublished information sources; however, none of these unpublished articles provided run timing or abundance records for the Chilkat and Chilkoot rivers. A total of four literature sources contributed eulachon run timing records and abundance descriptions for the Chilkat-Chilkoot area (Mills 1982; Magdanz 1988; Betts 1994; Ryan 2012).

The ADFG Division of Subsistence published three reports in the 1980s and 1990s that documented eulachon harvests of the Chilkat and Chilkoot rivers (Mills 1982; Magdanz 1988;

Betts 1994). Mills (1982) reported historical and contemporary fishing activities by residents of Klukwan, which were documented through interviews and participant observation in 1982 as part of a larger study on resource use patterns in Klukwan. Magdanz (1988) described harvests and trade of Chilkat and Chilkoot River eulachon, which included information from interviews in 1988. Betts (1994) reported findings from an ethnographic study of eulachon as a subsistence resource of the Chilkat and Chilkoot rivers; this study took place in 1990 and 1991 as a response to local concerns over perceived eulachon abundance declines and potential impacts of airport construction to Chilkat River harvests.

The Chilkoot Indian Association (CIA) and Takshanuk Watershed Council (TWC) conducted a three-year study funded by the U.S. Fish and Wildlife Service to identify spawning extents and to estimate abundances of Chilkat and Chilkoot River eulachon from 2010-2012 (Ryan 2012). Mark-recapture methods were used to estimate abundance for the annual run in the Chilkoot River; however, there were insufficient samples to estimate eulachon abundance of the Chilkat River due to the braided nature of the river (Ryan 2012). This report identified abundance estimates for 2010-2012 for the Chilkoot River and run timing dates for 2010-2012 for both the Chilkat and Chilkoot River.

2.2.3 Other sources

Other potential sources of information included photographs, museum writings, and websites. Photographs and museum writings were archived at the Sheldon Museum and Cultural Center. Online searches also identified photographs from the Alaska Digital Archives of University of Alaska Fairbanks and run timing information from ADFG. However, no specific run timing or abundance records were available from these sources, so these sources were not included in analyses.

2.3 Data integration and analysis

Observations of eulachon run timing and abundance were documented from secondary sources and integrated with LTK to construct temporal trends of the Chilkat and Chilkoot rivers. Run timing records were synthesized from LTK and secondary sources and organized into an Excel database. Each record was labeled with the phase of the eulachon run it represented (Table 2) and individually identified by the year and source of the observation.

Table 2: Phases of a eulachon run. Run timing records were labeled by the phase of the run that they represented. Each phase is defined below.

Phase	Definition
Start	The beginning of the run, first entry upriver, or first observation of eulachon
Peak	The time of the run when eulachon abundance or density was highest
End	When the last eulachon have entered the river or no more are present in the river
Before	The eulachon run has not yet arrived or migrated upriver
After	The eulachon run has already occurred and ended
Unspecified	A record or observation of eulachon; phase of the run unknown
Other	Neither observations nor records, e.g., predictions

Each run timing record was coded by Julian date, and all records were individually reviewed for accuracy and correction of errors. Each record was then reviewed on a case-by-case basis to determine validity. Records that met any violations of validity (Table 3) were excluded from analysis but were retained for discussion of the results.

Table 3: Violations of run timing validity. Each violation is defined and clarified with an example of an invalid run timing record.

Violation	Example
The record could not be assigned a date to during, immediately before, or immediately after the run.	A newspaper article reported on the eulachon run after it occurred but did not provide any run timing dates.
The year of the run was unknown.	A respondent recalled an observation but could not recall the year.
The accuracy of the record was questionable.	A respondent was uncertain of the date of the observation.
The record was from neither the Chilkat nor Chilkoot rivers.	An observation was for a different river.
The record was an anomalous observation that may not represent a run.	A respondent observed a single eulachon in the river.

Some respondents would refer to recent eulachon runs by the number of runs that have occurred since, rather than how many calendar years have passed. For example, a respondent would refer to the previous year run, in 2012, as "two years ago" to mean "two runs ago." Since the interviews were conducted a few months after the spring eulachon run, it was sometimes unclear which year of observation a respondent was describing. When reviewing these recent individual records for validity, if the calendar year was not clarified in the data, "x years ago" was treated as "x runs ago." Thus, these records shared a pattern and were cross-checked for inclusion in the analysis.

Run timing records from primary and secondary sources were synthesized, and first observations of the run were charted for each river by year, where first observations were defined as the earliest observation of the eulachon run in each river for a given year. A simple linear regression was performed in R 3.1.3 (R Core Team 2015) on date of first observations by year in order to evaluate trends over time. Likert values and descriptions of abundance were collected from interviews, and results were organized by decade and year. Qualitative abundance information from LTK and secondary sources were integrated to chronologically describe abundance observations and trends.

Wildlife names were identified through free listing (Bernard 2006) and entered into an Excel database by respondent code. For purposes of analysis, wildlife common names were formatted for consistency and alphabetical sorting; consistent formatting included lowercase text, correction of spelling errors, and singular form of wildlife names. After alphabetical sorting, wildlife names were quantified by the number of mentions in free listing. Wildlife names were then organized by their appropriate category: bird, marine mammal, land mammal, and fish. LTK observations of wildlife behaviors and interactions were then qualitatively described in relation to eulachon runs. The semi-structured interviews provided additional information from local observations and understandings of eulachon runs in the Chilkat-Chilkoot area. LTK were reviewed, synthesized, and summarized to describe local perspectives on eulachon life history and ecology.

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3 Historical and contemporary roles of eulachon

This chapter provides background information on the roles that eulachon historically and contemporarily provide to indigenous peoples and local residents near the Chilkat and Chilkoot rivers. Historical information was primarily summarized from literature sources, and contemporary information describes LTK from respondent involvement with eulachon runs through harvesting (n = 18), oil rendering (n = 16), research participation (n = 4), and other activities.

3.1 Tlingit culture

The Tlingit people are a Pacific Northwest indigenous group who primarily occupy areas of coastal Southeast Alaska, where their cultures are closely tied to marine resources for subsistence and trade (Goldschmidt and Haas 1998). Tlingit cultures follow a matrilineal social structure of moieties, clans, and houses. The two major moieties, Eagle (Wolf) and Raven, are divided into clans. The clans are social groups of people descended from the same ancestor, which are then made up of clan houses, or family groups affiliated with the same moiety (Goldschmidt and Haas 1998). Tlingit groups from the same area often identify with a village or community, which in present day are often identified as tribes.

There are two Tlingit groups whose traditional territory is in the Chilkat-Chilkoot area: The Chilkat Tlingit (Jil<u>k</u>áat <u>K</u>wáan) and the Chilkoot Tlingit (Jil<u>k</u>óot <u>K</u>wáan) (Goldschmidt and Haas 1998). These groups are sometimes collectively referred to as the Chilkat Tlingit (Goldschmidt and Haas 1998), but they also identify themselves separately and are affiliated with their separate tribes, the Chilkat Indian Village (CIV) in Klukwan and the Chilkoot Indian Association (CIA) in Haines.

In the Chilkat-Chilkoot area, eulachon hold a strong history of importance to the local Tlingit peoples, including as a cultural, nutritional, and trade resource. Historically, several traditional harvesting and processing sites were located along the Chilkat and Chilkoot rivers (Figure 3). These locations are often referred to by their mile post number along the Haines Highway, which follows the north bank of the Chilkat River and connects Haines and Klukwan (Betts 1994).

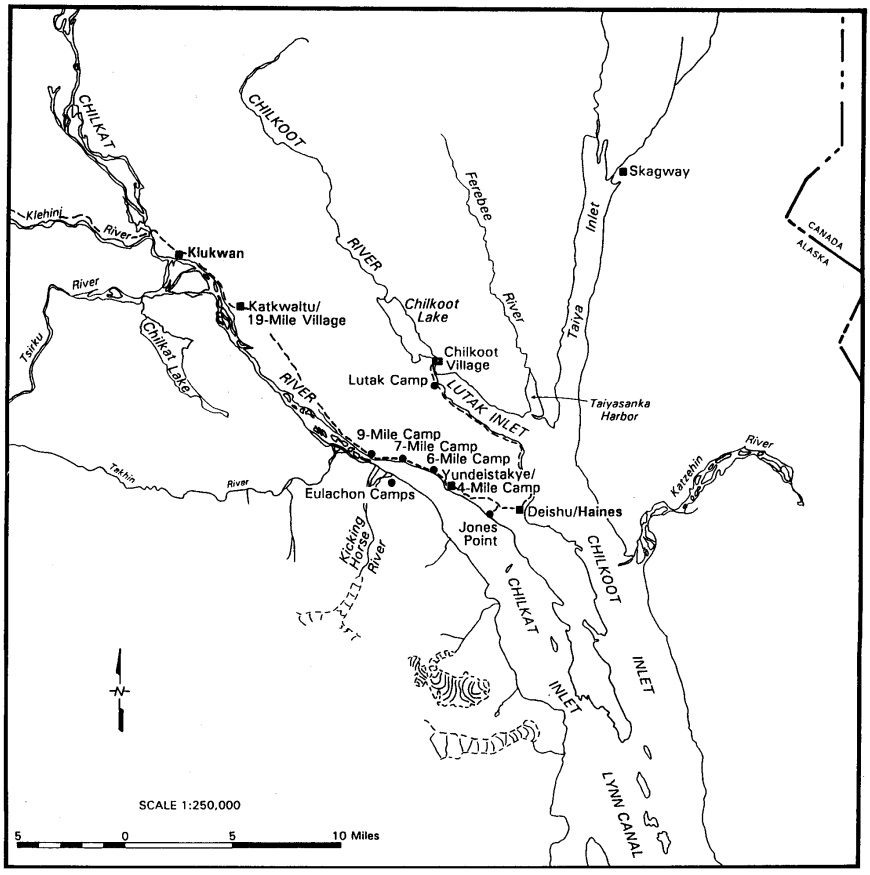

Figure 3. Eulachon harvest and oil rendering camps on the Chilkat and Chilkoot rivers. Reproduced with permission from Alaska Department of Fish and Game. Source: Betts, Martha F. 1994. The subsistence hooligan fishery of the Chilkat and Chilkoot rivers. Alaska Department of Fish and Game Division of Subsistence, Technical Paper No. 213, Juneau. http://www.adfg.alaska.gov/techpap/tp213.pdf

According to a well-known Tlingit story in the Chilkat-Chilkoot area (Betts 1994), eulachon were first introduced to the Chilkat and Chilkoot rivers through a marriage between a Klukwan leader and a woman from the Nass River in British Columbia. One of the elders interviewed in this study retold the Tlingit story of how Chilkat and Chilkoot river eulachon runs first appeared:

> There were no hooligan in Chilkat and Chilkoot. One of the leaders from Klukwan married a woman from Nass River. He and his wife went out, and one night she said "Gee, I wish I was eating hooligans." Her husband asked her, "When do hooligans come to Nass?" And she told him. So he worked with what the white man call Shaman. He said

"Send your nephews down to Nass just before the hooligans show up at at Nass River and get one hooligan. Put some kind of string on it and tow it all the way up." So that's what they did from Nass River up to 4-Mile. That's how the hooligans came.

There are traditional Tlingit rules that govern the harvesting and processing of eulachon from the Chilkat and Chilkoot rivers, and these are based on traditional beliefs about eulachon runs. Betts (1994) documented many of these customs, while noting that not everyone adhered to them. These included waiting to harvest eulachon until after they migrate upriver a certain distance; not throwing rocks, jumping, swimming, or splashing in the water; not making loud noises; not polluting the river; maintaining tidiness and cleanliness of fishing and processing sites; and excluding menstruating women from harvesting (Betts 1994). These customs were said to show respect for "hooligan people," which were described as having personalities of happiness, contentment, and sensitivity to their environment (Betts 1994).

Eight of twenty respondents interviewed in this study also described traditional harvesting behaviors and customs, including not causing disturbances to the river, waiting until eulachon migrate upriver past a certain distance, and respecting eulachon. Based on comments from four respondents, disturbances in the river deter or scare eulachon away. These disturbances could include, for example, allowing dogs in the river, using outboard skiffs, driving vehicles through the water, throwing rocks in the river, or walking barefoot in the river. Disturbances in the Chilkat River, which is wide and braided, could cause eulachon to instead migrate on the south side of the river, where harvesters cannot easily access them.

Elders taught people to respect the eulachon, especially the scouts, which were described as small male eulachon that migrate upriver first to survey or prepare the spawning grounds and report to the rest of the run. According to three respondents, harvesting too early or disrupting the scouts will deter the rest of the run from migrating upriver to spawn. One respondent recalled that when he was growing up, no one harvested until the village leader said they could. He described that nowadays, people try to catch eulachon as soon as they arrive. The culture camp on the west bank of the Chilkoot River now serves as a distance marker for some people. Two respondents described that eulachon need to reach the culture camp before harvesting, and one of these respondents said that people agreed not to fish above the Chilkoot Bridge in order to guarantee future returns.

Similar to what Betts (1994) reported in the early 1990s, the effectiveness of these rules is changing due to lowered adherence by Tlingit users and an increase in harvesting by non-traditional users. One respondent explained that he tries to maintain that respect in the Tlingit culture as more people are behaving in disrespectful ways. As traditional knowledge is shared among the community, non-Tlingit harvesters may also practice these customs. One non-Tlingit respondent recognized that LTK holds value, noting that "it is not all science."

3.2 Harvesting

Both the Chilkat and Chilkoot rivers support eulachon harvests by Tlingit people and local residents of Haines and Klukwan. Of the twenty respondents, eighteen have participated in or regularly harvested eulachon. Long-handled dip nets have commonly been used to catch eulachon, and they were historically wooden and triangular in shape (Hakkinen 1975). Women usually sewed the web for nets and men constructed the dip net frames (Betts 1994). Lightweight aluminum dip nets became available in the mid-1970s (Betts 1994) and are round with metal frames (Hakkinen 1975). Since they were lighter, these store-bought dip nets became more common than handmade nets. Throw nets, also known as Hawaiian throw nets or cast nets, have been used by some local residents in the past (Betts 1994), but they became popular for harvesting eulachon of the Chilkat and Chilkoot rivers around 2007. They are circular in shape and are thrown into the river around a school of eulachon (Betts 1994). Respondents described that the throw net is more efficient than the dip net, but some respondents noted that the splashing caused by the throw net might disturb eulachon. Respondents in this study primarily harvested eulachon from shore using dip nets, throw nets, or handmade nets, though buckets and hoop nets had also been used.

In general, respondents harvested eulachon from both the Chilkat and Chilkoot River, though not necessarily both within the same year. Since eulachon runs can be unpredictable, respondents would often harvest from whichever river had the first eulachon run or whichever run appeared more abundant. Some respondents also considered other factors when deciding where to harvest, including travel distance, convenience, and weather conditions. However, some respondents had preferences for harvesting from one river over the other. Three respondents said they preferred to regularly harvest from the Chilkat River due to presence of traditional family fishing sites and noting that the eulachon were larger and easier to clean. Only one respondent

stated a preference for harvesting eulachon from the Chilkoot River, and this was due to the clear nature of the river, which he stated makes eulachon easier to see for harvesting.

People often worked together in groups to harvest their desired quantities, which were roughly measured by gallon-size buckets. Some groups harvested large amounts of eulachon in order to render oil, and individuals also commonly harvested smaller quantities for personal and family use. Since eulachon harvests of the Chilkat and Chilkoot rivers are not regulated, harvest quantities are often based on personal estimates.

3.3 Oil rendering

Oil rendering was a common historical form of processing eulachon in the Pacific Northwest, and it remains a common practice in the Chilkat-Chilkoot area (Betts 1994). Eulachon oil is an important resource in the Tlingit culture, and respondents of the Chilkat-Chilkoot area value eulachon oil for a variety of uses, including eating with food, taking as a dietary supplement, using for medicinal purposes, and giving away or trading. Oil rendering follows a generalized process of harvesting, fermenting, and cooking eulachon to collect, and store oil. However, different individuals, families, or even communities follow their own methods of oil rendering. Sixteen of twenty respondents have participated in oil rendering, either through facilitating or assisting with rendering.

Rendering eulachon oil is an involved process that requires time and group effort, though the process has become more efficient over the years with increased technology and modern materials (Betts 1994; Goldschmidt and Haas 1998). Eulachon are harvested during spawning runs, in which large batches of eulachon are fermented in a container or similar form, such as a tub or a pit (Betts 1994; Goldschmidt and Haas 1998). Oil rendering sites are located along both the Chilkat and Chilkoot rivers, though more commonly along the Chilkat River at 4-mile and in Klukwan. Fermentation may last from a few days to a few weeks, with the latter more common in the past. When eulachon oil is cooking, some people dip crackers into the fresh oil. The fresh oil was described as sweet; however, one respondent warned that eating too much could upset the stomach.

Once rendered, however, eulachon oil was described as an acquired taste. Respondents commonly ate eulachon oil with a variety of foods, especially fish and potatoes. The oil was treated like a condiment on boiled fish, smoked fish, and *náayadi* (half-dried salmon).

Respondents also added oil to fish soup, dipped dry fish in oil, and used oil for preserving cranberries and other foods. The oil is rich in calcium, fatty acids, and vitamins (Kuhnlein et al. 1996). Some people take eulachon oil as a daily dietary supplement or for medicinal purposes, such as for arthritis, tuberculosis, or cancer. Respondents described that the oil is believed to help lower cholesterol, strengthen the immune system, and reduce aches and pains.

One respondent observed that while seal oil does not freeze or solidify, eulachon oil changes from liquid in warm temperatures to solid in cool temperatures. According to two respondents, eulachon oil should be stored out of the sunlight and in a cool place to preserve the flavor. However, some people kept eulachon oil in direct light to serve as a barometer. For this use, a jar of eulachon oil may be placed in windowsills to predict the weather, where clear oil forecasts good weather and cloudy oil forecasts storms. Betts (1994) also reported the use of eulachon oil as a barometer for weather or personal events, where a milky appearance predicts stormy weather and a reddish color means an upcoming personal or family disaster.

3.4 Trade and other uses

According to what Betts (1994) documented in 1990 and 1991 about harvesting and processing, the work was generally divided between men and women. There were some generalities but not without exceptions. Generally, men harvested and performed the heavier tasks, such as hauling eulachon, cutting wood, building fires, stirring eulachon during oil rendering, and cleaning out the vats. Women generally directed the cooking process of oil rendering, which included judging the timing of when to add water, when to stir, and when the oil was ready for skimming. Women also directed adjustments to the fire and temperature and were in charge of storing and sharing oil. Children helped out by carrying items or completing other tasks.

Respondents harvested eulachon most commonly for oil rendering (n = 12) and smoking (n = 12). Eulachon were also dried (n = 6), frozen (n = 6), cooked fresh (n = 5), traded or given away (n = 4), or jarred (n = 2). To smoke or dry eulachon, people may hang the eulachon whole or fillet them first. Some respondents preferred male eulachon for smoking and drying because they are larger and easier to clean than the females, which often contain eggs. Fresh eulachon were also pan-fried or stored through freezing or jarring for later use. Fresh and preserved eulachon, including oil, were also traditionally traded or given away to ill or elderly people who

were unable to harvest. Some of the respondents noted that they gift eulachon oil to elders, family, or friends in other communities who do not have access to eulachon runs. Eulachon oil was a valued item at Tlingit ceremonies and events, where the oil was given away or served with food.

Eulachon oil was a common historical and contemporary trade item from the Chilkat-Chilkoot area. Although many Pacific Northwest coastal indigenous groups traditionally harvested eulachon, many communities without direct access to eulachon runs obtained eulachon and eulachon oil through trade. In Southeast Alaska, the Chilkat and Chilkoot Tlingit traded with island communities of Southeast Alaska and interior communities of Canada. From the south, the Chilkat and Chilkoot Tlingit traded eulachon and eulachon oil for red cedar canoes, baskets, dentalium, mother-of-pearl, and shark's teeth; from the interior, eulachon and eulachon oil were traded for skins, furs, sinew, and lichens (Krause 1956; Betts 1994). Trading remained prevalent even after the introduction of western items and, according to respondents, still occurs today.

Respondents have traded eulachon oil with other coastal communities and interior communities, often in exchange for resources not commonly available in the Chilkat-Chilkoot area. These included, for example, trade with coastal communities for herring eggs, black seaweed, smoked cockles, and halibut or with interior communities for moose, caribou, and deer meat. Due to the historical value of eulachon oil as a trade resource with interior groups, trade routes linking coastal and the interior communities are referred to as "grease trails" (Collison 1941; Betts 1994). One respondent called eulachon oil "liquid gold," due to its high value in trade.

3.5 Additional activities

Respondents have also acquired knowledge of eulachon runs through other forms. Some respondents have engaged in recreational activities, such as photography of wildlife, eulachon runs, and harvests. Other respondents have kept journal records and notes based on observations and participation in activities. Some respondents have discussed eulachon runs with other members in their community. Additionally, four of the respondents have participated in research studies that have occurred in the Chilkat-Chilkoot area. These have included ethnographic studies done by the Alaska Department of Fish and Game (Mills 1982; Magdanz 1988; Betts

1994), biological studies done by local agencies (Ryan 2012), and educational and outreach activities.

3.6 Summary

Most respondents have conducted or participated in harvests and oil rendering of eulachon. Harvesting was primarily conducted from shore using dip nets or throw nets, though some local residents believe throw nets disturb the eulachon runs. In the absence of harvest regulations, traditional customs and community rules have dictated the timing and locations of eulachon harvests. Eulachon were harvested for a variety of consumptive purposes, including oil rendering. Tlingit respondents in this study described eulachon harvests and oil rendering as traditional ways of life, and the eulachon and oil were considered a necessary part of their diet. In addition, some residents have acquired LTK of eulachon runs through photography and observations, participation in research studies, and communication with other residents. Eulachon harvests and oil rendering remain strong in the Chilkat and Chilkoot Tlingit cultures, and non-Tlingit residents of the Chilkat-Chilkoot area also participate in various activities surrounding the eulachon runs.

4 Eulachon run timing and abundance

Run timing refers to the arrival or river entry of eulachon in the Chilkat and Chilkoot rivers, and abundance refers to the run size or number of eulachon in the run, which is measured in qualitative and quantitative descriptions. The results of these two topics are divided into sections that describe general information based on LTK and trends over time based on specific observations synthesized from multiple sources. Local and traditional knowledge was documented from respondents to describe various aspects of run timing and abundance of eulachon in the Chilkat and Chilkoot rivers. Observations of run timing and abundance for specific years were synthesized from LTK, historical records, and scientific data to quantitatively and qualitatively describe trends over time. These records are listed by time period in a complete appendix of run timing and abundance observations (Appendix F).

4.1 Run timing

According to respondents, the spring eulachon runs in the Chilkat and Chilkoot rivers typically occur between late April and early May each year (Table 4).

Table 4: Typical spring run timing. Respondents were asked when eulachon typically run in both the Chilkat and Chilkoot River, and their responses were grouped by time period. The number of responses for each time period is shown for each river.

Time Period	Chilkat River	Chilkoot River
Early April	1	1
Mid-April	2	3
Late April	14	14
Early May	14	14
Mid-May	3	2
Late May	1	1

4.1.1 Run indicators

Respondents described a variety of indicators that have alerted them to the arrival of eulachon runs in the Chilkat-Chilkoot area (Table 5). These indicators are often used to identify the run timing start date of eulachon runs in the Chilkat and Chilkoot rivers.

Table 5: Indicators of eulachon runs. Indicators identified by respondents were categorized as wildlife, environment, and other indicators, where n is the number of respondents who identified each indicator.

Indicator	n
Wildlife	
Gulls	15
Sea lions	8
Birds	6
Whales	3
Animals, unidentified	1
Ducks	1
Pinfish (sand lance)	1
Herring	1
Seals	1
Environment	
Tides	5
Smell	4
"Hooligan weather"	3
Oil on water	1
Other	
Visual observation and test dipping	13
Communication with others	9

In the Chilkat-Chilkoot area, the most common type of indicator listed by respondents was wildlife, especially gulls. Large numbers of gulls are observed or heard in the Chilkat-Chilkoot area, and they are seen gathering together in groups and following schools of eulachon.

When gulls were observed in Berners Bay, 57 kilometers north of Juneau (Sigler et al. 2004), this was an indicator to local people that the eulachon runs would soon begin in the Chilkat-Chilkoot area; typical observers of these gulls included people traveling to or from Juneau by plane or boat. As the eulachon run approaches in the Chilkat-Chilkoot area, the presence of birds may increase each day. The birds were noted as an especially important indicator for eulachon runs of the Chilkat River, and birds were seen in large aggregations, diving for eulachon. One respondent noted that the birds could be seen traveling towards whichever river has the first eulachon run.

Sea lion activity was also an indicator of eulachon runs, though more commonly observed near the Chilkoot River than the Chilkat River. When sea lions were observed chasing fish, local people would investigate to determine if the fish species was herring or eulachon. They communicated their findings to other people in the community. If sea lions were close to the Chilkoot River Bridge, this was indicative that they were most likely chasing eulachon; sea lions would even chase eulachon up into the river. Though observations of cetacean or seal activity were less commonly listed as indicators, this does not necessarily mean that they are observed less during eulachon runs.

Two fish species were identified as indicators of imminent eulachon runs: pinfish (Pacific sand lance *Ammodytes hexapterus*), which is also known as needlefish (Betts 1994; Brock and Coiley-Kenner 2009), and Pacific herring *Clupea pallasii*. Pinfish were identified as the first fish of the year to come into the Chilkat River, also attracting volumes of gulls near the river mouth. They were described as smaller than eulachon and with needles on their backs. Eulachon runs were said to arrive about a week after the run of pinfish. The presence of herring was also a sign that eulachon could be present; when sea lions and seals were observed chasing fish, the fish in the area could be herring or eulachon.

In addition to observing wildlife behaviors, respondents watched for certain environmental characteristics to predict timing of eulachon runs. High tides were described as an important indicator of eulachon run timing. Respondents tracked large high tides in springtime, particularly in April and May, to determine when to start watching for signs of eulachon. Respondents explained that eulachon enter the rivers during these large tides because the currents and high water levels assist eulachon in traveling upriver by requiring them to expend

less energy than would be required in lower water levels. Concurrently, sea lions were observed traveling upriver during high tides.

Changes in the weather may also indicate the arrival of eulachon runs, including what three respondents called "hooligan weather" on the Chilkat River. "Hooligan weather" was described as the presence of winds and dust storms over the mudflats of the Chilkat River, where silt blows through the air and dust settles everywhere. One respondent stated that "hooligan weather" occurs when the snow melts and before the trees have new leaves. According to these respondents, the dust storms occur immediately before the eulachon runs on the Chilkat River. A fourth respondent also listed this type of weather as an indicator, though he did not specifically call it "hooligan weather." Two other respondents described that they can smell the presence of eulachon, and one noted that eulachon are so oily that the surface of the water shows a coating of oil when eulachon are present.

Thirteen respondents said they directly observe or check for eulachon to confirm runs. In the springtime and near the timing of high tides, respondents would watch for signs of eulachon and visibly check for their presence in the Chilkoot River, which is typically clear. In the Chilkat River, respondents could check for presence by dip netting. The biomass of eulachon could also be seen moving through the marine environment, particularly by people who regularly observe or are flying over the ocean. Many people in the local communities communicated with each other about the start of the eulachon runs and about abundance. People who travel to and from Juneau, by boat or ferry, would inform local residents if they see flocks of birds, numerous sea lions, or "big black masses" of eulachon in Berners Bay; these observations indicated that eulachon should soon arrive in the Chilkat and Chilkoot rivers.

4.1.2 River differences

Nine respondents, all of whom have lived in the Chilkat-Chilkoot area throughout their lives, discussed observations related to differences in run timing between the Chilkat and Chilkoot rivers (Table 6). Though five of these respondents stated that eulachon run in both rivers at the same time, one of these respondents noted that they historically were different. This respondent, who regularly harvests and has lived in Haines off and on since the 1960s, stated that eulachon runs in the Chilkoot River used to consistently arrive five to seven days after the Chilkat River run; however, beginning in about 2011, the runs started occurring at the same time.

Out of the other four respondents who noted differences in run timing, two respondents said the Chilkat River is typically earlier. Three of the four respondents said there are differences in run timing between the two rivers by about a week, though two of these respondents said the Chilkat River run is usually the earlier run.

Table 6. Run timing differences between rivers. Nine respondents discussed observations of run timing differences between the Chilkat River and Chilkoot River. All nine respondents self-identified as Tlingit and have lived in the Chilkat-Chilkoot area, either consistently or intermittently, throughout their lives; respondent ages ranged from 55 to 83 years old at the time of the interviews.

Observation	n
Eulachon run timing is typically the same in both rivers	4
Eulachon run timing is sometimes the same in both rivers	1
Eulachon run timing differs by about a week between the Chilkat and Chilkoot river	3
Eulachon run timing of the Chilkat River is typically earlier than the Chilkoot River	2
Eulachon run timing of the Chilkat River used to be earlier than the Chilkoot River	1

4.1.3 Run duration

During the interviews, all respondents were asked about the typical duration of eulachon runs for each river. Sixteen of twenty respondents commented on the Chilkat River, and fourteen of twenty respondents commented on the Chilkoot River. Many respondents described duration in numbers of week, including typical duration, ranges, and irregular occurrences. Respondents' responses about typical duration ranged from four days to a month for the Chilkat River and three to fourteen days for the Chilkoot River (Figure 4). The Chilkat River run can last as long as three weeks, though eulachon have been caught in the Chilkat River as long as thirty days after the start of the run. The Chilkoot River run was portrayed as shorter, with a minimum length of three days and a maximum of two weeks.

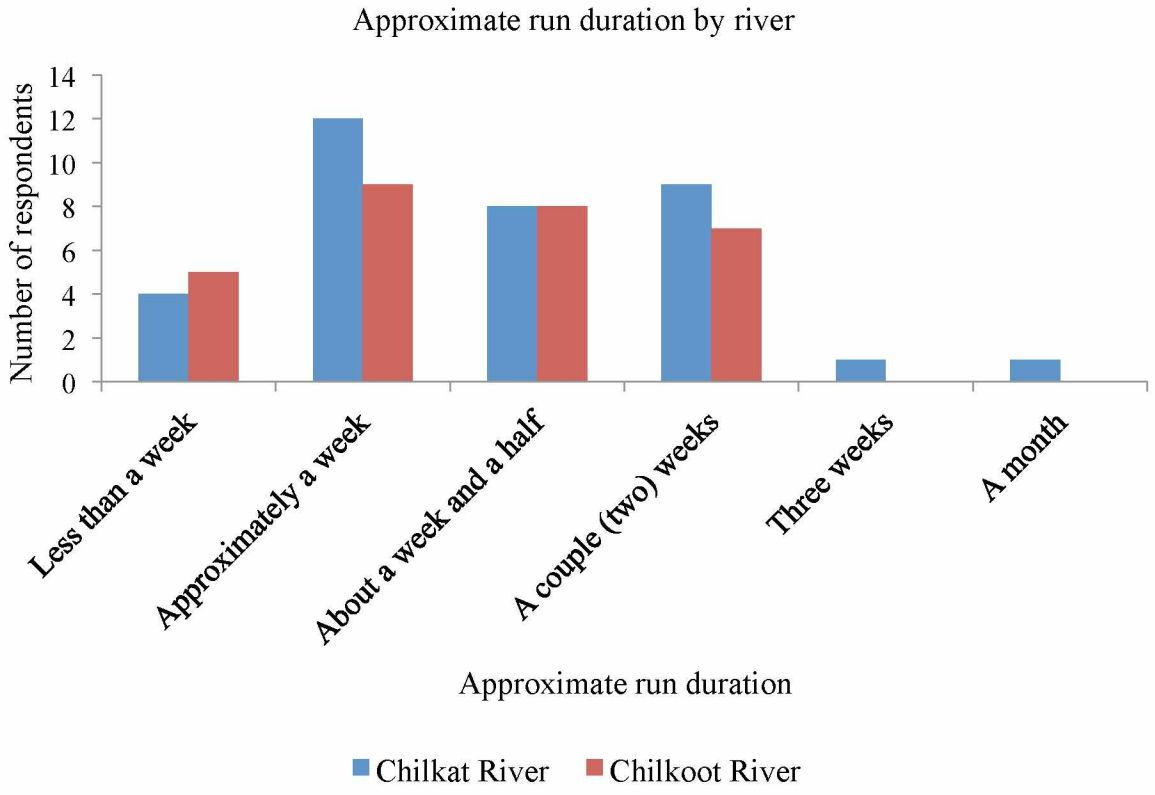

Figure 4: Duration of eulachon run by river. Respondents identified the typical duration of eulachon runs for each river. Typical duration ranges from four days to a month for the Chilkat River and three to fourteen days for the Chilkoot River.

Most people described that the run duration is variable and unpredictable. Because of this, many people immediately harvest at the start of the run, as harvesters do not know how long the run will last. A few respondents noted that the duration can vary over the years, including one comment that the Chilkat River run seems to be getting longer, where two weeks in recent years is not uncommon. Some respondents discussed rarities, such as when the runs lasted for only a couple days or as long as a few weeks. However, another respondent said the Chilkat River run typically ranges from two weeks to a month. In general, the eulachon runs of the Chilkat River were described as longer than eulachon runs of the Chilkoot River, though a couple of respondents estimated that the Chilkoot River runs are about the same duration as the Chilkat River runs. These varying comments demonstrate that eulachon run duration is not well-understood, possibly due to variations in runs or different perceptions of run timing.

4.1.4 Winter runs

In the Chilkat River, two spawning runs may occur in a year: a winter run, generally in February, and the annual spring run in late April and early May. Of twenty respondents, sixteen were aware of a winter Chilkat River run. The winter Chilkat River run was described as small and short. Some respondents said they have always been aware of or heard about a winter run. However, many respondents only first noticed the winter runs in early 2013, when eulachon runs were observed in the Chilkat River in February. People harvested winter eulachon that year at 8.5-Mile, 9-Mile, and 10-Mile of the Chilkat River. Those who were previously aware of the winter run noted that the weather is usually too cold for people to go out and that the river is usually ice-covered, preventing visibility and making access dangerous. According to one respondent, February 2013 was relatively warm with less ice on the Chilkat River.

The Chilkoot River was not thought to have a winter run, though one respondent stated there is one. Four respondents were uncertain if the Chilkoot River had a winter run, but they considered the possibility due to the recent February 2013 Chilkat River run. Though the Chilkoot River is not thought to necessarily have a winter eulachon run, three respondents have observed eulachon in or near the Chilkoot River in winter: one respondent noted that eulachon only travel as far as the river mouth in February, while the other two respondents have observed small numbers of one and twenty fish, respectively, in the river in winter. Based on LTK from interviews, the Chilkoot River is frozen in winter and the access road is closed, which limits observations of river activity.

4.1.5 Temporal trends

Run timing observations from LTK were integrated with records from secondary sources, primarily newspaper articles, to construct temporal representations of run timing for the Chilkat and Chilkoot rivers (Figure 5). Observations for the Chilkat River and Chilkoot River dated back to 1984 and 1985, respectively. The Chilkat River had fewer observations than the Chilkoot River; however, both rivers had consecutive observations from 2006 to the final year of the study in 2014. Run timing tended to become earlier over the full time series in both rivers; however, the temporal trend was only statistically significant in the Chilkoot River (ß = -0.31, $F_{1, 22} = 5.23$, $P = 0.03$) and not in the Chilkat River (ß = -0.25, $F_{1, 11} = 1.39$, $P = 0.26$). Calendar year

explained less than 20% of the variation in the first date of the run (R^2 = 0.19 and 0.11 for the Chilkoot and Chilkat rivers, respectively).

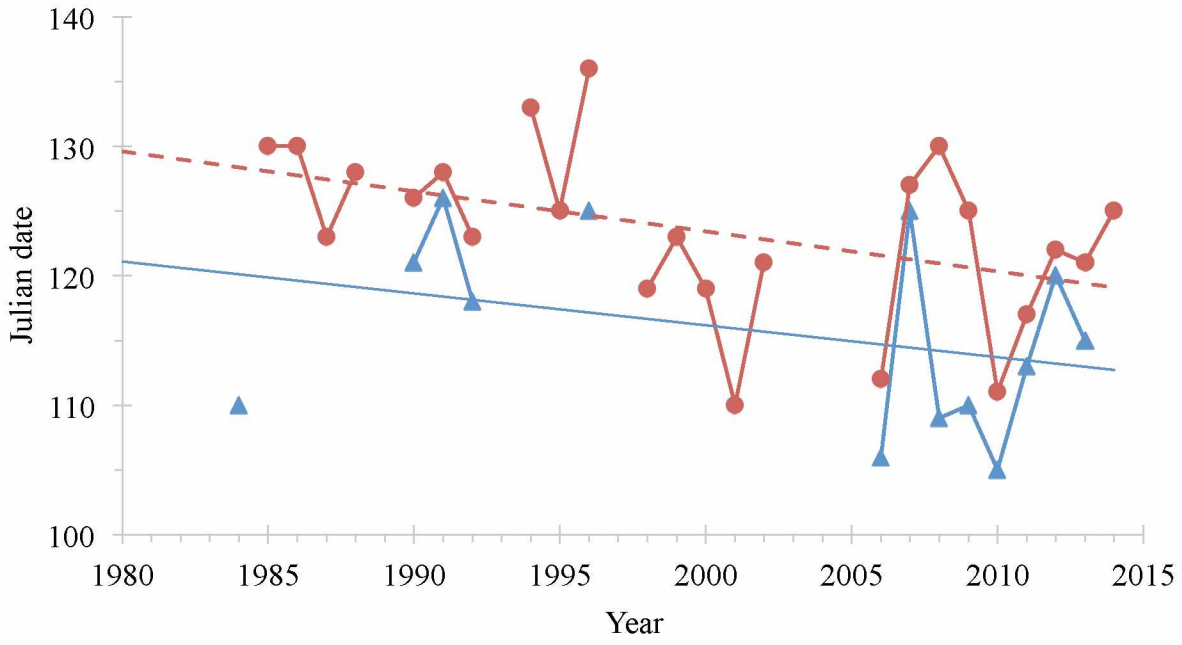

Figure 5: Run timing observations. Julian date of the first observation of the eulachon run in the Chilkat River (blue triangles, solid line) and the Chilkoot River (red circles, dashed line) are charted by year. The linear regression was statistically significant in the Chilkoot River (P = 0.03) but not in the Chilkat River (P = 0.26).

One respondent had documented the arrival of the eulachon run of the Chilkoot River almost every year that he had lived in Haines, providing records back to the mid-1980s. Another respondent kept records of eulachon runs of both rivers, dating back to the mid-2000s. Many of the Chilkat River records of run timing were collected from newspaper reports on eulachon runs. However, there was insufficient data for Chilkat River observations to detect any strong trends in run timing.

Many respondents considered eulachon run timing to be rather reliable, usually beginning in late April or early May. However, some respondents had noticed changes in run timing. Two respondents, one from Haines and one from Klukwan, identified a shift towards earlier runs in late April that began around 2006 and 2007. Prior to this shift, eulachon run timing was described to historically occur later, around May 10 to May 15. It was also discussed that, in the

Chilkat River, eulachon used to consistently arrive the first week of May and shifted earlier to arriving the last week of April. Three respondents noted that climate change could influence run timing, and two of these three respondents suggested that earlier eulachon runs occur in warmer years. Water levels, river temperature, and timing of glacial melt were also noted to influence eulachon run timing. Another respondent was unsure what caused the shift towards earlier run timing, but he also noted that the weather was warmer in the years that had earlier runs.

4.2 Abundance

4.2.1 Abundance indicators

Respondents described eulachon abundance based on different variables and methods, such as the abundance of birds, duration of the run, harvest success, and size of eulachon. According to one respondent, who would fly home to harvest eulachon when the runs were strong, the presence of many gulls forecasted an abundant eulachon run. Some respondents may look at the duration of the run to indicate abundance. However, one respondent said that sometimes eulachon have been abundant in the Chilkat River even when the duration was as short as a day or two. People also believed that eulachon runs may appear short when the main eulachon run never migrates upriver after being alerted of dangers by scouts (True 2000); this suggests that the population abundance could be greater than appears if the main run shows river avoidance and migrates elsewhere. These variables are not without influence from other factors, and thus, are not individually consistent indicators of abundance.

Additionally, abundant runs were said to include eulachon that are larger in body size than normal. This was also previously described by Betts (1994), where some local harvesters predicted eulachon abundance based on the size of individual fish: larger fish equated a strong run that would last longer, while small fish indicated a brief run (Betts 1994). Migration distance upriver also indicated abundance; if eulachon migrated as far as 6-Mile up the Chilkat River, the eulachon may continue even further upriver (Betts 1994).

4.2.2 Variability of abundance

Respondents described the abundance of eulachon runs as variable and unpredictable for the Chilkat and Chilkoot Rivers, where the abundance could be strong in some years and weak in

others. Four respondents described abundance fluctuations as cyclic. However, the time frame of these cycles were described differently, including a low abundance of eulachon every ten years, a difference in abundance every third year, and fluctuations between high and low. There could also be consecutive years of low abundance followed by abundant years, or vice versa. In some years, eulachon abundances in one river could be more abundant than the other; one respondent thought that abundances in the Chilkoot River are generally lower, based on the perception that eulachon harvests are higher in the Chilkat River.

Most respondents (n = 8) commented that abundance is too variable to detect an overall increase or decrease. However, two respondents believed that abundance is decreasing, while two others perceived the abundance to be increasing in recent years. An elder who harvested and rendered oil ever year described that eulachon runs used to be so abundant that one could almost walk across the river on top of the eulachon. The newspaper also described that a long time ago, the eulachon were so thick someone could walk across the Chilkoot River and that the run lasted the whole month of May (Bigsby 2004). However, two other long-time residents thought that eulachon abundance is increasing over the years, especially in recent years on the Chilkoot River, which is clear. The Chilkat River abundance was described as seemingly stable but difficult to assess, as the water is turbid. The Chilkat River February run, however, was described as generally small. Another long-time resident who did not actively participate in harvests noted that the local eulachon runs always seem good based on other residents' harvests.

A local resident quoted in a newspaper article described that eulachon abundance used to be greater in the Chilkat-Chilkoot area, noting that the number of existing eulachon pits is an indication to how many eulachon used to be harvested; he said that he had fished for twenty years and used to harvest more than three pickup truck loads a year (True 2000). It was also noted that the Chilkat River run was historically more abundant than the Chilkoot River run (True 2000). The newspaper also reported views of the local Alaska Native residents, including perceptions of decreased abundance and potential causes. It stated that some local Alaska Native residents considered major construction projects near the river to have influenced eulachon abundance, including a drop-off in eulachon runs on the Chilkat River after an airport extension and blasting near the river (True 2000).

Some respondents recalled years where there were no eulachon runs in the Chilkat and Chilkoot rivers. One respondent described that, when this happens, eulachon run in Skagway

rivers instead, but he noted that the Skagway area also has its own run. It was described that when eulachon run in Skagway instead of the Chilkat or Chilkoot River, the runs there are so thick and dense that eulachon can be caught by hand; one respondent said that this high density is due to the narrow river and additional eulachon. Some respondents believed that the change in harvesting gear and increase in throw nets may disturb eulachon; however, one respondent was unsure if throw nets influenced abundance of eulachon in the Chilkat River, noting that eulachon seemingly could migrate along the other side of the Chilkat River to avoid the nets.

4.2.3 Abundance trends

Abundance records based on LTK, historical sources, and scientific data are summarized by year or time period (Figure 6); records of these observations can be found in Appendix F.

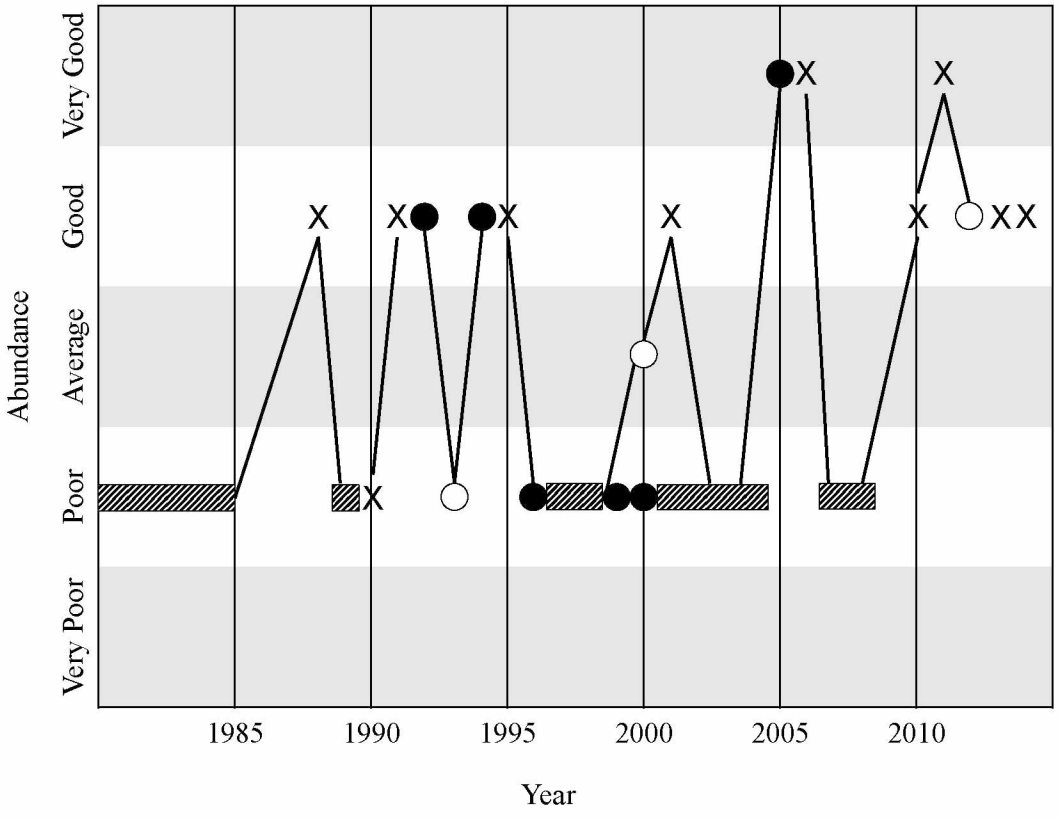

Figure 6. Abundance observations. Qualitative records of abundance (see Appendix F) of eulachon in the Chilkat-Chilkoot area were categorized (ranging from very poor to very good) by year where possible (black circles = Chilkat River; white circles = Chilkoot River; X = both rivers or river unspecified). Hatched bars represent general observations where the specific year and river were not specified.

Most records of abundance prior to 1990 were from the late 1980s and few from earlier decades. In the 1940s, eulachon were reportedly absent from the Chilkat River for five years following highway construction. A respondent described that, in the 1970s, quantities of eulachon were seined in the ocean prior to their spawning. He described that, though the following year was considered a normal run, harvest numbers were low in years following. Little information was available for most of the 1980s, and the late 1980s were reportedly poor years based on few records of abundance.

There were many records from the 1990s, following concerns of declines and published reports (Mills 1982; Magdanz 1988; Betts 1994) that addressed the concerns. Around 1990, there were perceived local declines, especially for the Chilkat River due to concerns of airport construction effects on eulachon runs. The early to mid-1990s showed eulachon runs of the Chilkat River to be strong, though the latter half of the decade was described as weak or non-existent. Chilkoot River abundance observations were fewer; however, they similarly showed low abundance around 1990. The Chilkoot River was not thought to have a run in 1993 but was considered extensive in 1995.

There was little information from the 2000s, and the Chilkat River run was weak or non-existent in 2000. The Chilkoot River was considered to have been a great run in 2005, with good runs in the Chilkat-Chilkoot area the following year. However, one respondent said that there were no eulachon runs in either 2005 or 2006. Runs of the latter half of the decade, however, were described as small.

The most recent years, from 2010 to 2014, included many abundance observations and estimates from scientific studies. In 2010, abundances in both rivers were considered high. Around 2010, many eulachon of the Chilkat River run migrated onto the golf course and got stranded during a high tide; this could have been due to a combination of high abundance and a high tide. The Chilkoot River run was estimated to be 2.2 million (Ryan 2012). The 2011 Chilkoot River run was estimated to be about 12.6 million, five times more abundant than the previous year (Ryan 2012). There was little information about the Chilkat River run in 2012, but it was considered better than normal. However, there were different opinions about how it compared to previous years. Ryan (2012) estimated the Chilkoot River run to be 7.1 million, larger than 2010 but smaller than 2011. However, some respondents stated the 2012 eulachon

runs of both rivers were larger than in previous years. The 2013 and 2014 run years were considered average or better.

This high prevalence of recent observations could be due to various reasons. Since these are the most recent years, respondent memories could be stronger or more documentation may be available. Additionally, there were more respondents present in the Chilkat-Chilkoot area during these years; therefore, there would be more observations overall. Since newspaper articles were more recent, there is a greater probability of them being located in both original and digital formats. Finally, the recent eulachon study conducted by the Takshanuk Watershed Council and Chilkoot Indian Association provided Chilkoot River abundance data from 2010 to 2012, which were estimated from mark-recapture methods (Ryan 2012).

4.3 Run timing and abundance hypotheses

We hypothesized that eulachon runs of the Chilkat-Chilkoot area might be occurring earlier over time, based on climate-driven environmental changes (Ricker et al. 1954; Moody and Pitcher 2010) and previously documented earlier runs in other locations (Joyce et al. 2004; Moody and Pitcher 2010). Quantitative and qualitative information from this study support that eulachon run timing of the Chilkat-Chilkoot area is variable year-to-year but, overall, is shifting earlier over time. LTK from interviews indicated that run timing is or appears to be shifting earlier, in general, from early or mid-May to mid- or late April. From integrating LTK with other sources, run timing observations were charted and show a general trend of earlier runs over time (see Figure 5). By integrating run timing dates from the 1980s to present, it appears that run timing has shifted earlier over the years for the Chilkoot River, showing agreement with local observations. The Chilkat River also demonstrates that trend; however, there were fewer years of data to support these trends, and the earliest record for the Chilkat River was of a relatively early run (mid- to late April). Our results collectively support qualitative observations that eulachon runs are currently more common in April, compared to historically being more common in May.

The start date of eulachon run timing, also referred to as river entry, was hypothesized to differ between the Chilkat and Chilkoot River, based on local observations that eulachon runs arrive in the Chilkat River before they arrive in the Chilkoot River (Betts 1994). LTK from respondents in this study suggested that eulachon run timing for the Chilkat River is normally a week earlier than runs of the Chilkoot River. However, respondents who have lived in the

Chilkat-Chilkoot area for many years suggest that, although the Chilkat River run was historically earlier, the runs are now closer together in timing. Betts (1994), who documented LTK from the Chilkat-Chilkoot area in the early 1990s, also supported that the Chilkat River run arrived before the Chilkoot River run. Although LTK from this study suggests that eulachon run timing might differ between the Chilkat and Chilkoot River, quantitative data were too limited to evaluate differences in run timing.

We hypothesized that eulachon abundances of the Chilkat and Chilkoot rivers would be declining based on records of local concerns from the late 1980s and early 1990s (Betts 1994) and federal listings of southern eulachon populations (NMFS 2011; COSEWIC 2011). As most information was qualitative and subjective, there was difficulty assessing any trends in abundance. However, we found that the residents of the Chilkat-Chilkoot area expressed differing opinions about eulachon abundance trends. Generally, abundance was described to fluctuate, with no clear overall trend. Many of the respondents who lived in the Chilkat-Chilkoot area for fewer years perceived less of a change than longer-term residents. Additionally, some respondents expressed that the Chilkat River is declining in abundance, while the Chilkoot River appears to be increasing. Some respondents expressed that although eulachon may appear to be declining or absent in the Chilkat River, they believed that the reality is that they are migrating upriver along the south bank of the river, where harvesters cannot access them. Alternatively, eulachon were described that, if absent one year from a river, they are spawning in a nearby location; therefore, population abundances cannot be assessed.

5 Local perspectives on life history and ecology of eulachon

Respondents provided additional information from local observations and understandings of eulachon runs of the Chilkat-Chilkoot area related to different characteristics of eulachon life history and ecology. Because this information emerged from a semi-structured format, not all respondents addressed every topic.

5.1 Marine populations and morphology

Respondents often described eulachon runs of the Chilkat and Chilkoot rivers as separate populations, and some respondents described differences in run timing and morphology of eulachon from each river. However, some respondents referred to eulachon runs of the Chilkat-Chilkoot area as one run, including comments that eulachon migrate back and forth between the rivers.

5.1.1 Marine behaviors

When sixteen respondents were asked about eulachon behaviors before and after migrating upriver to spawn, only four discussed marine behaviors of eulachon. One respondent described that eulachon fry hatch in the river and then migrate to the ocean to live as adults. Another respondent agreed that eulachon mature into adults in the deep ocean. A third respondent, who is a biologist, noted that little is known about eulachon behaviors in the marine environment. Two of the respondents who were interviewed together stated that eulachon return to the rivers to spawn every five years. According to them, eulachon migrate from the ocean in groups to their natal streams to spawn. They were described to "stick together" in groups like Tlingit clans, where eulachon natal to the Chilkat River group together and migrate separately from eulachon natal to the Chilkoot River. Preceding spawning runs, respondents have observed biomasses of eulachon migrating towards the rivers, especially while traveling by plane over the ocean.

5.1.2 Morphological differences

Five respondents discussed morphological differences between Chilkat and Chilkoot river eulachon, including differences in color and size. Three of these respondents described that

there are color differences between Chilkat and Chilkoot river eulachon. According to two respondents, who were interviewed together, Chilkat River eulachon are purple in color, while Chilkoot River eulachon are blue in color. Additionally, males of the Chilkoot River are a darker blue than females. They described that, "in each area, their colors change because of the waters." The third respondent described that Chilkat River eulachon are purple and have broader backs, while Chilkoot River eulachon are gold and slimmer; he theorized that the differences in body size are due to more prey near the Chilkat River. Two other respondents, however, said that there are no size differences between eulachon of the two rivers.

Eleven respondents answered a question about changes in body size of eulachon over time. Eight of the eleven respondents had not noticed any differences in the size of eulachon over the years, and one respondent was unsure but thought eulachon might have become smaller over the last 15 to 20 years. The other two respondents discussed that the size of eulachon varies over the years. One respondent described that eulachon runs occur in cycles of size and age, noting that larger fish are older fish. The other respondent observed that eulachon are small in some years and big in other years, describing that large runs have large eulachon.

5.1.3 Sexual dimorphism

Of eighteen respondents, five could not tell males and females apart. One of these respondents commented that male and female eulachon do not seem to change body shape as they enter the rivers the way that salmon do. The other thirteen respondents described physical differences between male and female eulachon (Table 7).

Table 7: Sexual dimorphism. Thirteen respondents described physical differences between male and female eulachon of the Chilkat-Chilkoot area, where n is the number of respondents who listed the physical difference.

Males	n	Females	n
Larger, longer	10	Smaller, shorter	7
Skinnier	1	Streamlined, skinny	2
Firm	3	Fat, plump, round, softer bellies	5
Gametes (milt)	1	Gametes (eggs)	3
Scaly and scratchy; raised ridge along lateral line	5	Slippery, slick, smoother skin, shiny	4
Longer snout	1	More round head	1
Deep blue (Chilkoot)	2	Light blue (Chilkoot)	2

In general, females are smaller than males (Figure 7). However, one respondent described that physical size differences depend on the river: whereas male eulachon of the Chilkoot River are larger than females, eulachon of the Chilkat River do not differ as much in size between males and females.

Figure 7. Female and male eulachon. A female eulachon is shown on the left and a male eulachon on the right. Photo courtesy of Emily Files, KHNS Radio.

5.2 Spawning run characteristics

Once eulachon arrive at the estuary, they may wait for an environmental signal to migrate upriver to spawn. Some respondents discussed that eulachon show river avoidance when spawning conditions are not good and will instead migrate to other nearby rivers. Scouts, small male eulachon that migrate upriver first, were said to check or prepare the spawning conditions of the river and report to the rest of the run. If conditions were good, the scouts would communicate to the rest of the eulachon to follow. However, LTK responses varied about whether the remaining male and female eulachon migrate upriver together or at different times. Respondents described other variables that influence run timing and river entry of eulachon, including water temperature, weather, air temperature, lake ice, and wildlife pressure. Some respondents noted that earlier eulachon runs often occur in years with warmer weather.

5.2.1 River entry and avoidance

When fifteen respondents were asked how eulachon know when to enter the river, eleven respondents mentioned one or more influences on their behaviors (Table 8). Scouts (small male eulachon that migrate upriver prior to the main run), tides, and ecological influences were the most common influences identified by respondents.

Table 8. Influences on eulachon run timing and river entry. Fifteen respondents described influences on eulachon run timing and river entry in the Chilkat and Chilkoot rivers, where n is the number of respondents who mentioned each influence.

Influence	n
Scouts	5
High tides	5
Temperature	3
Wildlife pressure	2
Adaptation to freshwater	1
Innate	1
Daylight hours	1
Water turbidity	1
Weather	1

Five of fifteen respondents described that eulachon run timing occurs around the largest high tides in late April and early May. Respondents described that these large magnitude high tides assist eulachon in migrating upriver by requiring them to expend less energy. According to one respondent who regularly harvested eulachon,

> The bigger the tides, the more the water floods further into the rivers. The water is deeper and there is a current… the eulachon don't have to work as hard. The eulachon can make a major move [upriver] with the tide and expend less energy. They start running at the beginning of big tides, but other environmental factors, like water temperature, come into play.

Among other variables that were described to influence run timing and river entry of eulachon, some respondents described water temperature and related environmental cues, including weather, air temperature, and lake ice break-up, to influence eulachon behaviors. Respondents suggested that eulachon know when to run by watching water temperature, noting that eulachon wait or run later if the river is too cold. One respondent compared Chilkoot River eulachon runs to herring, noting that herring wait in the bay for the right temperature before spawning. Another respondent described that the break-up of ice in the Chilkoot Lake, which is influenced by weather and air temperature, affects river temperature and eulachon run timing; the respondent noted that the river may be too cold for eulachon when the lake is still frozen. Some respondents described that, in years where eulachon runs were observed earlier than normal, the weather was warmer in those years.

Five of fifteen respondents described "scouts" as important influences on river entry. Respondents referred to scouts as small male eulachon that migrate upriver first to assess or prepare the spawning grounds of the river. According to respondents, if conditions are good, the scouts would communicate to the rest of the eulachon to follow. They have also been described as the first run of eulachon and have been called the "clean-up crew." Tlingit elders interviewed in this study had referenced scouts when describing traditional rules of harvest and respectful behaviors. One respondent said, "if you dip too early, you chase [the eulachon] away." If conditions are not good, scouts were described to turn back and eulachon runs would migrate elsewhere, such as to Skagway. In those years, eulachon runs were reportedly absent in the

Chilkat or Chilkoot River. Two respondents mentioned wildlife as an influence on river entry, with one respondent describing how sea lions and whales can drive eulachon into the rivers, while the other respondent noted that sea lions could conversely influence eulachon runs away from the rivers.

5.2.2 Differential timing

Based on responses from five respondents, it was unclear if male and female eulachon migrate upriver at the same time. Three respondents identified that scouts, small male eulachon, run first. However, there was little agreement among respondents about the order of migrating male and female eulachon of the main run: two respondents said that females migrate upriver before males; two other respondents said that males migrate upriver first; and the fifth respondent said that female and male eulachon migrate upriver together. According to one of the respondents, female eulachon migrate upriver first and male eulachon migrate upriver four days after. One of the respondents described that the early part of the run is usually all males, the middle of the run is a mixture of males and females, and the end of the run is mostly female eulachon. However, he described that the timing, like many characteristics of eulachon, is variable and inconsistent. This respondent, who is a biologist, described that observations of male and female eulachon may differ by locations along the river.

5.2.3 Spawning sites

LTK about eulachon spawning is limited, as respondents did not generally observe eulachon once they had completed their harvests. However, three respondents offered information about eulachon spawning behaviors. According to one respondent, eulachon prefer to spawn in sand. The other two respondents indicated that eulachon prefer or sometimes spawn in brackish and intertidal areas. When respondents were asked about eulachon behaviors after spawning in the Chilkat and Chilkoot rivers, most respondents described or speculated that eulachon return to the ocean, though not necessarily implying that they survive.

Based on responses from five respondents, eulachon have migrated upriver as far as 7-Mile to 10-Mile in the Chilkat River. The Chilkat River is turbid, and presence of eulachon is verified primarily by harvesting at specific locations. According to one respondent, upriver distances can differ by years, but 7-Mile was the furthest he had seen eulachon. Another

respondent said eulachon used to migrate up to 8-Mile but no longer do. Similarly, a third respondent said eulachon used to migrate up to 9-Mile but not anymore; he speculated that highway construction affected this change. Another respondent agreed that eulachon have traveled as far upriver as 9-Mile, noting that eulachon have never been caught near the village of Klukwan. However, the fifth respondent said that eulachon do still travel as far as 9-Mile.

The Chilkat River is wide in lower reaches, and two other respondents described that eulachon run more on the other side of the river than they used to. Haines Highway runs along the north side of the Chilkat River, and the "other side" refers to the opposite side, or the south side, of the river where access is difficult. One of these two respondents described that changes to the Haines Airport in the 1980s affected the habitat:

> The Haines airport used to be in further, closer to the mountain. It was changed in the early 1980s. Our parents said it will change the river because of silt coming from the glaciers – the hydrologists agreed – but it was changed anyway. Now, the airport is further into the Chilkat River, and there is a buildup of sand at 4-mile.

In the Chilkoot River, most harvesting occurs near the culture camp or below. However, eulachon have been observed above the culture camp. Two of four respondents said that eulachon might go as far as the Chilkoot Lake; however, another respondent said that eulachon do not go past the culture camp because they do not like the "sweet" water from the lake and prefer brackish water instead. The fourth respondent said that big swarms of eulachon can be seen coming up the Chilkoot with the big tide and up above the weir to spawn.

5.2.4 Behaviors after spawning

Based on responses by thirteen respondents about eulachon behaviors after spawning, there were different ideas about whether eulachon die or return to the ocean: five respondents were uncertain, five stated that eulachon return to the ocean, two believed that eulachon die, and one said that some eulachon die while others return to the ocean. After spawning, eulachon may leave the river and return to the ocean, which was described by one respondent to include three days of acclimation to saltwater. Of the five respondents who were not sure what eulachon do after spawning, three speculated or have heard that that eulachon return to the ocean. One of the

respondents who believed that eulachon die expressed uncertainty. The other respondent discussed that, about a week after eulachon spawn, dead eulachon wash out of the river to the ocean. This respondent also described how some people believe eulachon are still running, even after they die, due to the presence of gulls eating eulachon. One respondent suspected that eulachon runs include a mixture of eulachon that return to the ocean and eulachon that die; he described that some eulachon seem like they die after spawning because there are many dead fish found after spawning but that it also seems like some eulachon return to the ocean.

5.3 Wildlife presence at eulachon runs

Respondents participated in a free listing exercise (Bernard 2006) to identify firsthand wildlife observations during eulachon runs of the Chilkat-Chilkoot area. All twenty respondents participated in the exercise and described observations and behaviors of the wildlife.

5.3.1 Wildlife observations

Respondents have observed various birds, marine mammals, land mammals, and fish during, before, and after eulachon runs of the Chilkat and Chilkoot rivers (Table 9). The free listing exercise showed that birds, especially gulls *Larus* spp. and bald eagles *Haliaeetus leucocephalus*, are the most commonly observed wildlife by respondents. As described above, gulls were commonly the first indicator of eulachon runs, and various species of gulls have been observed at the mouths of the Chilkat and Chilkoot rivers. Gulls have been seen in thousands, predating on eulachon before, during, and after eulachon runs. Respondents described observations of gulls, including flying over a concentration of spawning fish, watching from trees, diving into the water, and scavenging on dead eulachon. Bald eagles were observed in lower abundances than gulls but were similarly observed feeding, hunting, and scavenging on eulachon, as well as chasing gulls. Some respondents have observed low numbers of ravens *Corvus corax* feeding on eulachon; crows *Corvus* sp. could be observed more commonly near the Chilkoot River than the Chilkat River. Various species of ducks and other birds have also been observed feeding on eulachon through hunting or scavenging.

Table 9: Wildlife observed during eulachon runs. Animal names were grouped under the categories of birds, marine mammals, land mammals, and fish and listed by standard common name. The number of respondents (n) who named each animal is provided.

Wildlife group	n
Bird	
Gull, unspecified	18
Bald eagle	15
Common raven	5
Bird, unspecified	4
Crow	2
Duck, unspecified	2
Hawk, unspecified	2
Kingfisher, unspecified	2
Scoter	2
Tern, unspecified	2
Albatross	1
Loon	1
Mallard	1
Merganser	1
Red-head duck	1
Sandpiper	1
Marine mammal	
Steller sea lion	16
Seal	12
Orca	6
Whale, unspecified	6
Humpback whale	5
Harbor seal	2
Porpoise, unspecified	2
Dall's porpoise	1
harbor porpoise	1
Walrus (or possibly male sea lion)	1
Land mammal	
Brown bear	8
River otter	7
Bear, unspecified	6
Mink	6
Marten	3
Black bear	2
Wolf	2
Coyote	1
Fish	
Dolly Varden	3
Pacific sand lance (pinfish)	3
Chinook salmon	2
Sockeye salmon	2
Trout, unspecified	2
Cutthroat	1
Sculpin (bullhead)	2

One respondent described that birds key into an area, usually whichever river has the first eulachon run, and stay there to feed even after eulachon begin running in the other river. He said that, in his experience, the Chilkoot run is usually first, and the seabirds, especially gulls, stay near the Chilkoot River even when the Chilkat River run begins. Another respondent said that, in approximately 2008 or 2009, there were no gulls on either the Chilkat or Chilkoot River, despite presence of a small eulachon run. A third respondent commented how, in some years, birds do not make any noise though they usually do.

Steller sea lions *Eumetopias jubatus* were another common indicator of eulachon runs, and respondents most commonly observed them near the Chilkoot River. Sea lions were described to feed on and chase eulachon near the mouth of the Chilkoot River and even follow eulachon up into the river. Seals *Phoca* spp. have also been observed feeding on eulachon near and into the Chilkoot River, though they were described to avoid sea lions. According to a respondent, seals may go as far into the Chilkoot River as Chilkoot Lake. Various whales and porpoises have also been observed during eulachon runs, including humpback whales *Megaptera novaeangliae*, orcas *Orcinus orca*, Dall's porpoises *Phocoenoides dalli*, and harbor porpoises *Phocoena phocoena*. Whales have been observed feeding on eulachon prior to the start of the eulachon run. Orcas would feed on eulachon, and respondents noted that they chased sea lions and seals; respondents have observed seals and sea lions on rocks and beaches when orcas were seen nearby. Though one respondent noted a sighting of a walrus, this may have been a reference to a bull (male) Steller sea lion instead.

Respondents commonly observed brown bears *Ursus arctos* and black bears *U. americanus* during eulachon runs, though not necessarily feeding on eulachon. Bears were more commonly observed near the Chilkoot River than the Chilkat River, and brown bears were seen more often than black bears. Some respondents have never seen brown bears eating eulachon, while others have observed them catching or eating eulachon. One respondent observed a sow brown bear teaching her cubs how to catch eulachon at the Chilkoot River. Though brown bears have been seen eating eulachon, respondents described the occurrence as occasional and that bears are more commonly seen walking around than eating. One respondent suspected that eulachon run timing might be a little too early in the season for much bear activity. However, bear activity does occur after the eulachon runs, posing a disturbance to oil rendering camps.

Respondents observed river otters *Lutra canadensis*, minks *Neovison vison* and martens *Martes* spp. near the rivers and catching eulachon, eating eulachon, or running along the river. River otters and minks have also been seen disturbing eulachon camps and pits. Wolves *Canis lupus* have been observed on the south side of the Chilkat River and have been heard in packs, but respondents have not seen wolves eating eulachon. However, respondents have observed coyotes *Canis latrans* catching eulachon. Domestic dogs *Canis lupus familiaris* have also been present during harvests and observed feeding on eulachon carcasses.

Respondents have observed other fish in the rivers during eulachon runs. Dolly Varden *Salvelinus malma*, sculpin, and cutthroat trout *Oncorhynchus clarkii* have been caught as bycatch in throw nets. One respondent described how he once caught a trout with a eulachon halfway down its throat. Sockeye salmon *O. nerka* have been caught as early as May 5 in the year, and one respondent once caught sockeye salmon during a eulachon run. Pinfish is a local name likely referring to Pacific sand lance (Betts 1994), and they were described to spawn around the same time and mixed with eulachon in the Chilkat River. A respondent described that pinfish get caught in eulachon nets but that people do not eat them. Near the Chilkat River mouth, king salmon *O. tshawytscha* have been observed feeding during eulachon runs, and respondents suspected they were eating eulachon. One respondent noted that capelin are present before eulachon runs and that herring spawn after, in late May.

5.3.2 Wildlife interactions

Nineteen of twenty respondents answered questions about wildlife interactions at eulachon runs, including interactions with other wildlife, with eulachon, and with people. Wildlife were said to influence harvesting activity, as the presence of abundant wildlife alerted people to eulachon runs, inducing harvesting and oil rendering preparations. The presence of wildlife also encouraged people to observe and photograph the activity of orcas, sea lions, and seals near the Chilkoot River. However, respondents generally did not consider wildlife as an influence to their behaviors at eulachon runs, though some considered that presence of specific wildlife species could influence their harvesting locations. Some respondents commented that, although they would avoid bears if present, they did not recall any occurrences where bears presented an issue. Sea lions, however, were noted to act aggressively during eulachon runs, and thus, they were generally avoided. Sea lions might also indirectly influence harvesting activities,

according to a respondent, as they could push eulachon to migrate up the Chilkoot River or to other areas.

Respondents generally did not consider their own presence to be a disturbance to wildlife activity, though some respondents commented that there could be potential effects. Predators might avoid harvesting locations where people are present, and wildlife might leave or avoid areas that are noisy from people harvesting. One respondent thought that birds do not mind his presence, while another respondent described that birds might leave an area where humans are present; both respondents were in agreement that human effects on sea lions have not been observed. In contrast, a different respondent said that human presence scares away sea lions. River otters and wolves were described to hide, and bears were described as wary. One respondent commented that busy harvesting activity during the day will keep bears away, and another respondent discussed that humans and bears mutually leave each other alone and that, through the years, bears learn and avoid the regular harvesting locations. It was also noted that car traffic deters bears from bothering oil rendering pits.

When asked how wildlife affects eulachon, most respondents discussed short-term effects on eulachon behaviors. The most commonly discussed effect on eulachon behaviors was wildlife influence on river entry of eulachon, especially from sea lions and the Chilkoot River. Six respondents discussed that sea lions and seals have a positive influence on eulachon river entry timing, as predators chase eulachon towards and into the Chilkoot River. However, one respondent described that sea lions could either coerce eulachon into the river or conversely prevent them from entering. Though eulachon are likely to scatter when eagles, humans, or sea lions try to catch them, the eulachon would usually return to the area. One respondent suspected that sea lions have influenced eulachon runs to migrate towards Skagway instead. This respondent also discussed that this kind of influence, where eulachon runs are redirected from their spawning river, could prevent eulachon from spawning at all that year. Wildlife have also been seen on the beach, after a eulachon run, feasting on eulachon that have washed up with the tides. Three respondents commented on how wildlife predators are a natural component of a eulachon's lifecycle, and one respondent noted that he did not think that wildlife have an effect on overall eulachon population abundance.

Respondents noted that they try not to interact or disturb wildlife during eulachon runs. However, interactions do occur when bears approach or disturb eulachon oil rendering pits,

though respondents said that these occurrences are rare. Respondents noted that bears rarely dig into the pits and that the occurrences were less frequent than in the past, possibly due to increased presence of car traffic on the Haines Highway. One respondent described that when a bear disturbed his pit, it wandered into the eulachon camp, scattered papers, and took a few eulachon. Another respondent described that, on one occasion, a bear scooped a couple of eulachon out of the pit; though only a small amount of eulachon were taken and the oil was still rendered, the oil was unable to be traded. The respondent described that this exposure to air when the bear disturbed the pit is bad for the eulachon, and the oil develops a reddish color that is not suitable for trade; the respondent said that the oil did not taste different despite the color. Notes from other respondents agreed that bears only take a few eulachon from pits. Another respondent said he prevents the issue of bears disturbing the oil by covering and locking his pit.

The presence of gulls, sea lions, and other wildlife are commonly observed during the arrival of eulachon runs in the Chilkat and Chilkoot rivers. Local residents of Haines and Klukwan commonly observe these wildlife species and other ecological observations as indicators of eulachon runs. Especially given the variability of eulachon runs, local observations are important components to identifying timing and other characteristics of eulachon runs. Though many of the wildlife identified in the free listing exercise are considered predators of eulachon (Willson et al. 2006), respondents did not always observe these wildlife preying on eulachon. Bears, in particular, are sometimes observed near rivers but not actively feeding on eulachon, possibly due to the influences of human presence on wildlife behaviors.

5.4 Summary

Scientific data and knowledge are limited about eulachon distribution and behaviors in the marine environment. Interviews similarly demonstrated that LTK on eulachon behaviors in the ocean are limited, as eulachon are rarely observed and not harvested while in the ocean. LTK suggests that morphological differences, especially color differentiations, can be used to distinguish Chilkat River eulachon from Chilkoot River eulachon. Although there is limited scientific information about color differentiations between populations, other morphological differentiations between runs have been reported (Willson et al. 2006). Population genetics studies do not show strong differentiation between eulachon populations (Candy et al. 2015), but the morphological differences between Chilkat and Chilkoot River eulachon documented in this

study suggest that they could be separate populations. However, these differences could be plastic responses to different environmental conditions between the rivers, such as the thermal regime during incubation (McPhee et al. 2012) or turbidity (Leclercq et al. 2010).

Respondents described various factors that could influence eulachon to migrate upriver (see Table 8). Published literature has also documented tides and other environmental conditions as influences on run timing. Although the environmental factors that influence eulachon run timing are not well understood throughout their range (Gustafson et al. 2010), tide height is considered as one of the factors to influence river entry (Spangler et al. 2003; Willson et al. 2006; Gustafson et al. 2010). Betts (1994) supported the LTK from this study that the beginning of the spring eulachon runs in the Chilkat-Chilkoot area usually corresponded with high tides in spring. Bishop et al. (1989) also observed eulachon run timing in the Chilkat-Chilkoot that corresponded with high tides, though eulachon sometimes spawned earlier than the highest tides. Following a high tide, eulachon were said to arrive in great numbers, occurring in "waves" (Bishop et al. 1989).

Many respondents mentioned that scouts migrate upriver first to check or prepare the spawning conditions and then communicate to the rest of the run when to follow. Based on LTK from this study, it was unclear if the remaining eulachon exhibit differential timing between males and females, as the responses varied about whether the male and female eulachon migrate upriver together or separately. More information is needed to better understand the environmental and ecological factors that influence eulachon run timing and abundance.

6 Discussion and conclusions

6.1 Review of the main findings

Local and traditional knowledge was documented about eulachon runs of the Chilkat and Chilkoot rivers of Southeast Alaska to characterize observations and changes in run timing and abundance. The results supported our hypothesis that eulachon run timing is shifting earlier in the year. However, the data were not sufficient to make conclusions regarding the hypotheses that there are differences in run timing between the Chilkat and Chilkoot River or that eulachon abundances in the Chilkat-Chilkoot area are declining.

In the Chilkat-Chilkoot area, eulachon runs generally occur in late April and early May. However, LTK from interviews suggests that eulachon runs arrive earlier in the year than historically. Qualitative and quantitative observations of run timing and abundance from LTK were integrated with historical sources and scientific data to explore changes in eulachon runs. Trends in eulachon run timing were constructed, dating back to the 1980s. These trends support LTK that eulachon run timing may be shifting earlier over time, though more information is needed for the Chilkat River. Similar observations of earlier run timing have been observed in salmon species in Southeast Alaska, possibly linked to changes in oceanic temperatures (Kovach et al. 2015). LTK also suggests that eulachon run timing may be linked to climate, as well as tides and other environmental variables. The causes of eulachon run timing variability are not well understood, but tide heights and water temperature have also been linked to run timing (Ricker et al. 1954; Spangler 2002).

Abundance observations were synthesized to qualitatively describe abundance observations over time. Respondents' perceptions of eulachon abundance could be influenced by various factors, such as abundance of birds, length of run, density of run, and harvesting success. Additionally, these factors are subject to bias from inconsistent methods and influences by other factors. For example, eulachon harvests are not monitored, and harvesters do not typically measure the quantity of eulachon harvested. People often estimated harvests by the number of units filled, such as gallon buckets, and harvest quantities are further subjected to bias based on harvesting effort, timing, and location.

Though a Likert scale was used for rating abundance, this proved to be an ineffective tool, as many respondents were reluctant to rate an entire decade, because eulachon exhibit variability

in abundance on much shorter time scales. Thus, there were insufficient data to quantitatively analyze eulachon abundances by decade. Additionally, respondents generally remembered the significant years and not the average runs, making it difficult to construct trends based on high- or low-abundance years.

These interviews demonstrated that there could be various factors that influence the perception of abundance, such as in-river location, duration of run, harvest success, and spawning runs elsewhere. Without a standard unit of measurement, abundance is difficult to assess. However, one of the surprising results was that most respondents did not observe any overall changes in eulachon abundances of the Chilkat and Chilkoot rivers over time, despite local concerns from the early 1990s (Betts 1994). We compared respondents' "information environments" (Beaudreau and Levin 2014), including type and years of experience, to their abundance observations. We expected older, long-time residents of the Chilkat-Chilkoot area to be more likely to express perceptions of eulachon declines, which can be explained by the shifting baseline syndrome (Ainsworth et al. 2008). However, there were no correlations between respondent characteristics and abundance perceptions. This surprising result could also be a consequence of the biological characteristics of eulachon; documenting abundance trends over decadal time scales may be more effective for species with longer generation times and less episodic recruitment variation (Beaudreau and Levin 2014).

These varying responses emphasize some of the struggles in assessing and monitoring populations of a poorly understood species like eulachon (Hay and McCarter 2000; Gustafson et al. 2010; Ryan 2012). Many biological characteristics, like population distinctions and marine distributions, could help explain variations in abundance. However, in the absence of scientific monitoring, LTK can augment existing scientific knowledge to create a more integrated understanding of eulachon life history to provide baseline information and study long-term trends of data-limited species.

6.2 Reflections on the methods

LTK was documented about various characteristics of eulachon runs of the Chilkat and Chilkoot rivers by conducting semi-structured interviews with twenty residents of Haines and Klukwan. These communities contain valuable knowledge about eulachon runs through the various forms of participation and observations, as well as through the rich Tlingit cultural ties of

the area. Making informal visits to Haines and Klukwan to become familiar with the communities, rivers, and eulachon runs later proved valuable in gaining rapport (Bernard 2006), as respondents appreciated that the interviewer had participated in local eulachon harvests. In addition, having local contacts from the community helped to meet local residents, establish rapport within the communities, and gain trustworthiness.

For the purposes of documenting baseline information and synthesizing observations for a data-limited species, we sought all available information on eulachon runs of the Chilkat and Chilkoot rivers. Thus, interviews were conducted with respondents who had knowledge about eulachon runs through various levels and forms of involvement, including harvesting, oil rendering, photography, research studies, cultural activities, and communication with others. We found that most respondents in this study have participated in harvests and oil rendering of eulachon, though some people participated more actively than others. In some cases, respondents kept logbooks of eulachon run timing based on observations of wildlife and harvest activity, though they may not have participated in eulachon harvests or other activities. In other cases, some respondents who were unable to harvest remained actively aware and knowledgeable of the eulachon runs through communication with others in the community.

Additionally, although we attempted to quantify respondent experiences based on years of participation in harvests and oil rendering, this proved difficult to analyze because some respondents would move away, come back, or return only to help during eulachon runs. Consequently, we were not able to formally analyze how an individual's "information environment" (Verweij et al. 2010; Beaudreau and Levin 2014) affected their response to various questions. However, all respondents, based on their personal and cultural ties to eulachon, provided valuable information about the biology of eulachon in this region.

Newspaper articles proved to be an abundant and valuable source of historical run timing and abundance records that would otherwise be difficult to obtain through interviews, as most respondents could not recollect dates and run size for specific years. Historical records have been utilized in other studies that document past information on eulachon (Gustafson et al. 2010) and other fish species (Hamilton et al. 2005). With the availability of documented LTK, archived newspaper articles, and other historical sources, baseline information on eulachon and other poorly understood ecological phenomena can be acquired.

6.3 Implications for future research

In addition to providing baseline information on run timing and abundance, LTK in this study revealed local perspectives on eulachon life history characteristics and ecological interactions that could inspire future research. These results highlighted some important life history characteristics (Table 10) that could help explain variations in run timing and abundance. In many cases, the information that respondents provided could be viewed as hypotheses for future scientific research on eulachon life history and ecology.

Table 10. Additional research topics. The results highlighted life history topics that could be important in future research studies on run timing and abundance variations in eulachon runs.

Research topic
Using morphological differences to distinguish eulachon populations
The presence and behaviors of eulachon scouts
The effects of differential timing on eulachon sampling methods
The frequency of iteroparity in eulachon populations

We found that local residents, similar to scientists, possess limited information about eulachon distribution and behaviors in the marine environment. Though eulachon spend 95% of their lifecycle in the marine environment (Hay and McCarter 2000), this was an unsurprising result. Because eulachon are not commercially valuable, there are few sources that document marine distribution of eulachon, and most documented information about eulachon biology relates to their spawning season (Willson et al. 2006). Similarly, LTK primarily comes from spawning runs, as eulachon are rarely observed and not harvested while in the ocean. However, information from surveys and bycatch data have provided some information (reviewed in Willson et al. 2006), and they agree with LTK that eulachon prey on plankton and appear to live near the ocean floor, though depths can vary. Though eulachon are rarely observed or harvested while in the ocean, there is an opportunity for LTK to provide local observations in an area where scientific data are currently limited. Through research projects that incorporate citizen science, where members of the public can assist in the research and contribute data, eulachon distribution in different regions can be documented to better understand eulachon populations and life history.

With limited information about eulachon distribution in the ocean, eulachon populations and migratory behaviors are not well understood. Similar to LTK in this study, Betts (1994) also reported color distinctions between Chilkat and Chilkoot River eulachon. In that study, local residents described Chilkat River eulachon as darker with black and blue sides and Chilkoot River eulachon as silver with spots. Although these descriptions are worded differently than how respondents in this study described color distinctions, both sources support that there could be morphological differences between the two eulachon runs. LTK suggests that morphological differences can be used to distinguish eulachon from different rivers, though eulachon genetics do not show strong differentiation between populations (Candy et al. 2015). However, understanding morphological differences between eulachon of separate runs could help to document occurrences of river avoidance and natal homing.

In traditional Tlingit culture, eulachon and other marine resources are considered sentient beings that must be respected to ensure future returns (Langdon 2006). Traditional Tlingit harvest methods and respectful practices have been documented for many animal resources, including salmon, eulachon, herring, and gull eggs (Emmons and De Laguna 1991; Betts 1994; Hunn et al. 2003; Langdon 2006; Thornton et al. 2010). For example, traditional methods for ensuring healthy herring populations included habitat conservation and transplanting herring eggs to new habitats (Thornton et al. 2010). In this study, Tlingit respondents described that traditional harvesting rules are important for respecting eulachon and ensuring future returns. Oftentimes, there are parallels between historical methods of indigenous fisheries management and common practices in modern fisheries management today. For example, an important traditional rule of harvesting eulachon is to wait until they reach a certain distance upriver, a practice that compares to escapement strategies for managing anadromous species like salmon (Bachman 2005). Like eulachon, salmon are similarly described as sensitive to the environment and must be treated with respect to guarantee future returns (Langdon 2006). According to the scientific literature, eulachon can assimilate pollutants from spawning rivers (Rogers et al. 1990) and may show river avoidance if polluted (Smith and Saalfeld 1955).

Betts (1994) reported that local residents of the Chilkat-Chilkoot area described the initial part of eulachon runs as consisting of males who migrate before females in order to prepare spawning grounds. They were referred to as the "cleanup committee" and were said to return downriver to communicate for females to follow (Betts 1994), similar to the eulachon scouts

described by respondents in this study. According to respondents, scouts are small male eulachon that migrate upriver first to prepare the spawning grounds and report to the rest of the run to follow. There is limited scientific information available to support the behaviors of scouts. However, a similar pattern is observed in Pacific salmon, where male salmon typically migrate to the spawning grounds earlier than females (Morbey 2000). However, it is thought that males exhibit this behavior in order to maximize their opportunity to mate (males might have fewer mating opportunities if they arrive late to the spawning grounds; Morbey 2000) and possibly to benefit from the advantage of prior residency in male-male competition for access to females (Foote 1990). Although the spawning behavior of eulachon is less studied than that of salmon, the sexual dimorphism of eulachon (see 5.1.3) suggests that intrasexual competition may be an important component of their mating system (Fairbairn 1997).

More information is needed to understand the prospects of differential timing and alternative reproductive strategies within eulachon runs and the implications these could have on fisheries research. Two important things to consider are the presence of scouts and the timing differences between male and female upriver migrations. Other studies have documented differential timing within eulachon runs, which could support that male and female eulachon migrate upriver at different times. As part of a mark-recapture population study (Ryan 2012), gender distribution of eulachon returning to the Chilkat and Chilkoot rivers were collected in 2010 and 2011. Sex ratios were documented daily during the runs at two sites on each river, 4-Mile and 6-Mile of the Chilkat River and within the location of the mark-recapture traps and upstream of the weir of the Chilkoot River.

In both years, female eulachon represented less than half of the sampled population. In 2010, females represented around 23% and 34% of the run in the Chilkat and Chilkoot rivers, respectively. In 2011, only 10% of eulachon were documented as females in the Chilkat River, though 26% of the sampled eulachon in the Chilkoot River were female. In addition, eulachon were documented beyond the Chilkoot Lake after spawning had occurred, and a sub-sample of this group resulted in 100% males (Ryan 2012). Differences in these sex ratios support that male and female eulachon may migrate upriver at different times. Betts (1994) reported that males enter the Chilkat River before females (Betts 1994).

Other studies have supported that young male eulachon may migrate upriver first. In the Twentymile River, a tributary of Turnagain Arm in southcentral Alaska, Spangler (2002) found

that young male eulachon (age-2) were more abundant earlier in the run and older males (age-4 and age-5) more abundant later in the run. River samples generally showed a higher male to female ratio (Willson et al. 2006). However, ratios have varied by date and river (Willson et al. 2006). In the Copper River, the sex ratio was about equal at the start of the run, but males were more abundant in the latter half of the run (Moffitt et al. 2002). The prospect of differential timing suggests that sex ratio estimates may be biased by differences in survey timing (Spangler 2002). Differential timing of eulachon could also suggest that males and females are exposed to different levels of predation (Willson et al. 2006).

Interviews indicated different ideas regarding eulachon semelparity. This does not necessarily address whether or not eulachon spawn more than once in their lifetime, but rather, whether or not eulachon return to the ocean after spawning. Suprisingly, few respondents indicated that eulachon die after spawning, where most were either unsure or noted that they return to the ocean. If eulachon return to the ocean after spawning, the question is whether they die after entering the ocean or if they will spawn again in future years. This raises the question of semelparity and the frequency of iteroparity in different regions.

Betts (1994) described eulachon of the Chilkat River to "roll back to salt water" after spawning, and some local residents reported that eulachon do not die before migrating back to sea. However, Bishop et al. (1989) documented that Chilkat River eulachon died after spawning in 1989. In the scientific literature, eulachon are described as "fundamentally semelparous," meaning they normally only spawn once in their lifetime but cases of iteroparity have been documented (Willson et al. 2006). Since local residents of an area do not commonly monitor eulachon runs after harvests are completed, there is a lack of both scientific data and LTK to investigate this topic.

Implications of these eulachon run characteristics could be applied to fisheries management of eulachon populations throughout their range and of other data-limited species. By providing local data for a specific place and over a long time period, LTK may complement scientific knowledge through refining and generating hypotheses, filling information gaps, and documenting different perspectives (Huntington et al. 2004; Gilchrist et al. 2005). In conclusion, these approaches can provide valuable information to understanding biological characteristics and temporal changes for eulachon and other data-limited species.

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Appendix A

Interview protocol

[Author's note: Questions A4 and D3 were not included in the first interview].

Part A: Experience with hooligan

1. What do you call this fish? (*show photo*)
    a. Do you know of any other names for [hooligan]? What are they?

2. (*Introduce timeline*) I would like to learn about your experiences with hooligan of the Chilkat and Chilkoot rivers.

    Born when/where?
    Currently live?
    Where else lived?

3. In what ways have you had experience with hooligan of the Chilkat and Chilkoot rivers?

    □ Harvesting
    Where?
    Years/How often?
    Methods/gear type?
    How much?
    What did you do with the fish?

    □ Oil rendering
    Fish from which river(s)?
    Years experience/How often?
    Where did you render oil?
    Can you tell me about the process of rendering oil?

How much fish?

How much oil?

What do you do with the oil?

□ Research

Where?

Years experience?

Can you tell me about the research?

□ Other

4. What do you value *most* about hooligan?

    a. What else do you value?

Part B: Run timing of hooligan

5. How do you know when hooligan are in the rivers?

    Can you tell me more?

6. CHILKAT RIVER: When are hooligan generally in the *Chilkat* River?
    a. In general, how many days are in a run?
    b. How many runs are there a year?

7. (*Refer to timeline*) I would like to ask you about specific years or decades of time. Do you recall when hooligan were in the *Chilkat* River in _____? (*ask for all years/decades for Chilkat River*)

a. Can you recall any years where the runs were significantly earlier/later than normal? Please tell me about them.

How many days?
Start? Peak? End?

8. CHILKOOT RIVER: When are hooligan generally in the *Chilkoot* River?
    a. In general, how many days are in a run?
    b. How many runs are there a year?

9. (*Refer to timeline*) I would like to ask you about specific years or decades of time. Do you recall when hooligan were in the *Chilkoot* River in _____? (*ask for all years/decades for Chilkoot River*)

    a. Can you recall any years where the runs were significantly earlier/later than normal? Please tell me about them.

    How many days?
    Start? Peak? End?

10. Have you noticed any changes in the timing of hooligan runs over the years? What are these changes?

    a. Have the runs become more or less predictable?
    b. Why do you think these changes have occurred?

11. Can you tell me about what the hooligan do before and after they enter the river?

    How do hooligan know when to enter the river(s)?
    Do they eat?
    Spawning?

What do they do after spawning?

12. Can you tell males and females apart?

    a. If yes, how do you tell them apart?
    b. Are the males and females in the river(s) at the same time?

13. Other thoughts?

Part C. Abundance of hooligan

14. Can you tell me about the abundance or run size of hooligan over the years?

    Any changes?
    Harder or easier to catch?
    Why do you think that is?

15. (*Refer to timeline*) I would like to ask you about specific years or decades of time for the *Chilkat* River. (*show abundance chart*)

16. (*Refer to timeline*) I would like to ask you about specific years or decades of time for the *Chilkoot* River. (*show abundance chart*)

17. Have you noticed any other changes in the hooligan? When?

    Body size?
    Males versus females?
    Other?

18. Other thoughts?

Part D. Predators

19. (*Free listing*) Please list all the animals that you have ever seen at hooligan runs.

Can you think of any other animals you have ever seen there?

20. Can you tell me more about what you see when the animals are at hooligan runs?

What are they doing?
When do they arrive?
Where are they on the rivers?

21. Please tell me about your experiences with the animals you see at hooligan runs.

a. How do the animals affect your behaviors at hooligan runs?
b. How do you think your presence affects the animals' behaviors?
c. How do you think the animals affect the hooligan?
d. Do you interact with any of the animals? How?

22. Have you noticed any changes in animals at hooligan runs?

Different animals?
Number of animals?
Timing?
Location?
Why?

Can you suggest other people in the area for an interview on these topics?

Interview # ____________

Interview # _____

Chilkat River								
1920s	1930s	1940s	1950s	1960s	1970s	1980s	1990s	2000s
Very High	Very High	Very High	Very High	Very High	Very High	Very High	Very High	Very High
High	High	High	High	High	High	High	High	High
Medium-High	Medium-High	Medium-High	Medium-High	Medium-High	Medium-High	Medium-High	Medium-High	Medium-High
Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium
Low-Medium	Low-Medium	Low-Medium	Low-Medium	Low-Medium	Low-Medium	Low-Medium	Low-Medium	Low-Medium
Low	Low	Low	Low	Low	Low	Low	Low	Low
Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low

Interview # _____

DECADE
1920
1930
1940
1950
1960
1970
1980
1990
2000
2010

YEAR (CHILKAT RIVER)									
1920	1921	1922	1923	1924	1925	1926	1927	1928	1929
1930	1931	1932	1933	1934	1935	1936	1937	1938	1939
1940	1941	1942	1943	1944	1945	1945	1947	1948	1949
1950	1951	1952	1953	1954	1955	1956	1957	1958	1959
1960	1961	1962	1963	1964	1965	1966	1967	1968	1969
1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
1980	1981	1982	1983	1984	1985	1956	1987	1988	1989
1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
2010	2011	2012	2013						

Interview # _____

Chilkoot River								
1920s	1930s	1940s	1950s	1960s	1970s	1980s	1990s	2000s
Very High	Very High	Very High	Very High	Very High	Very High	Very High	Very High	Very High
High	High	High	High	High	High	High	High	High
Medium-High	Medium-High	Medium-High	Medium-High	Medium-High	Medium-High	Medium-High	Medium-High	Medium-High
Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium
Low-Medium	Low-Medium	Low-Medium	Low-Medium	Low-Medium	Low-Medium	Low-Medium	Low-Medium	Low-Medium
Low	Low	Low	Low	Low	Low	Low	Low	Low
Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low

Interview # _____

DECADE
1920
1930
1940
1950
1960
1970
1980
1990
2000
2010

YEAR (CHILKOOT RIVER)									
1920	1921	1922	1923	1924	1925	1926	1927	1928	1929
1930	1931	1932	1933	1934	1935	1936	1937	1938	1939
1940	1941	1942	1943	1944	1945	1945	1947	1948	1949
1950	1951	1952	1953	1954	1955	1956	1957	1958	1959
1960	1961	1962	1963	1964	1965	1966	1967	1968	1969
1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
1980	1981	1982	1983	1984	1985	1956	1987	1988	1989
1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
2010	2011	2012	2013						

Interview # _____

Animals

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

Appendix B

Demographics form

Interview # _____

Information About You

What is your gender? 1 Male 2 Female

In what year were you born? _____

In what town or city do you currently live? _____

Which of the following do you identify with? *Please circle all that apply.*

1 Asian
2 American Indian or Alaska Native
3 Black or African American
4 Hispanic or Latino
5 Native Hawaiian or Pacific Islander
6 White
7 Other _____

Do you identify as Tlingit? 1 Yes 2 No

If Yes, what is your.....? (*Optional*)

Clan? _____

House? _____

Appendix C

Consent form

Informed Consent Form

Trends in run timing and abundance of hooligan (eulachon) in the Chilkat and Chilkoot rivers

IRB #439055
Date Approved 05/06/2013

Description of the Study:
You are being asked to take part in a study about hooligan (eulachon). The goal of this study is to learn more about hooligan in the Chilkat and Chilkoot rivers. We hope to learn about any changes that have occurred over your lifetime. You have been chosen as someone who knows about hooligan runs of the Chilkat or Chilkoot River.

Please read this form carefully and ask any questions before you agree to be in this study.

Your participation will involve a 1-2 hour long interview recorded on a voice recorder. The interview will be used to help learn about hooligan runs in the Chilkat and Chilkoot rivers. Questions may include when the hooligan are in the rivers, the size of the runs, and the animals you see at the rivers. The interview will be recorded to help in taking notes. You may ask for the voice recorder to be turned off at any time.

Risks and Benefits of Being in the Study:
We do not expect any risks to you if you take part in this study. You may feel uncomfortable being recorded. We will make every effort to hold the interview in a place and in a format that is most comfortable for you.
You may not receive any benefits from taking part in this study. The knowledge that we collect in this study might help to explain how hooligan runs are changing over time. This may help your community by providing more information about current changes.

Confidentiality:
Any information we collect will be kept private and stored in a locked office. Only the research team will have access to any information collected in the interview. If you are comfortable, the interviews will be audio-recorded to help in note-taking. Your name will be coded with a number so that no one can trace information to your name. At the end of the study, the recorded interviews will be destroyed or returned to you. The data from this study may be used in reports, presentations, and publications.

Voluntary Nature of the Study:
Your decision to take part in the study is voluntary. If you decide to take part in the study, you can stop at any time or change your mind and ask to be removed from the study.

Contacts and Questions:
If you have questions now, feel free to ask now. If you have questions later, you may contact:

Allyson Olds
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If you have questions or concerns about your rights as a research participant, you can contact the UAF Office of Research Integrity at 474-7800 (Fairbanks area) or 1-866-876-7800 (toll-free outside the Fairbanks area) or fyirb@uaf.edu.

Statement of Consent:
I understand the conditions described above. I confirm that I am of age 18 or over. My questions have been answered to my satisfaction, and I agree to participate in this study. I have been provided a copy of this consent form.

____ Yes, you may record the interview ____ No, you may not record the interview

____ I want the recording of my interview destroyed

____ I want the recording of my interview returned to me

Participant's Name	Signature	Date

Researcher's Name	Signature	Date

Thank you for your time, interest, and participation. Your knowledge is very valuable and appreciated

Appendix D

University of Alaska Fairbanks Institutional Review Board approval

(907) 474-7800
(907) 474-5444 fax
fyirb@uaf.edu
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Institutional Review Board

909 N Koyukuk Dr. Suite 212, P.O. Box 757270, Fairbanks, Alaska 99775-7270

May 6, 2013

To:	Courtney Carothers Principal Investigator
From:	University of Alaska Fairbanks IRB
Re:	[439055-2] Trends in run timing and abundance of eulachon in the Chilkat and Chilkoot rivers

Thank you for submitting the Revision to protocol documents referenced below. The submission was handled by Exempt Review. The Office of Research Integrity has determined that the proposed research qualifies for exemption from the requirements of 45 CFR 46. This exemption does not waive the researchers' responsibility to adhere to basic ethical principles for the responsible conduct of research and discipline specific professional standards.

Title:	Trends in run timing and abundance of eulachon in the Chilkat and Chilkoot rivers
Received:	May 3, 2013
Exemption Category:	2
Effective Date:	May 6, 2013

This action is included on the June 12, 2013 IRB Agenda.

Researchers have responded to all requested modifications.

Prior to making substantive changes to the scope of research, research tools, or personnel involved on the project, please contact the Office of Research Integrity to determine whether or not additional review is required. Additional review is not required for small editorial changes to improve the clarity or readability of the research tools or other documents.

Appendix E

Selected accounts of eulachon in local newspapers

[Author's note: Selected accounts include information on eulachon run timing, abundance, or wildlife of the Chilkat-Chilkoot area. Minimal edits, indicated by brackets, have been applied for clarification.]

Chilkat Valley News (CVN)
Serving Haines and Klukwan, Alaska

CVN 1975-0626
Volume X Number 15
June 26, 1975

Musings from the Sheldon Museum, Elizabeth Hakkinen

> Eagerly awaited every spring is the mid-May run of eulachon, an American candlefish much like smelt. During a short period of time – rarely as much as two weeks – these fish run up into the Chilkat and Chilkoot Rivers.
>
> The eulachon run is closely preceded by a run of pin-fish which travel to Klukwan and beyond. Checking that run, as this girl (photo) was doing in 1912, gives a fair estimate of how heavy the run of eulachon will be.
>
> Photo Caption:
> The small silvery fish, evidently plentiful when these canoe-loads were caught at 7-Mile in 1927, are not found in such great numbers in other sections of Alaska...
>
> Today's roads permit the people to live at home, and to carry the fish by car to permanent smoke-houses, as at 4-Mile in 1912 (below), and at 7-Mile in 1927 (right).

Standing on the bank of the river, or in a canoe, the fisherman moves his net slowly upriver to dip out the fish, as Ben Watson was doing at 7-Mile in 1927. His net appears to be heavy – and he already has a good catch in the canoe.

CVN 1985-0516
Volume XV Number 19
May 16, 1985

Spring MUST be here

Another sign of possible spring are the eulachon ("hooligan") which have provided sport and food since last week.

Photo Caption:
Hoorah for the eulachons. Despite the weather, they ran up the Chilkat River Norm Hotch and many others were dipping up the bonanza last week. [Photo by Ellen Starr.]

Photo Caption:
Waiting for the eulachon – surf scoters mass by the hundreds near Letnik Cove.

CVN 1987-0514
Volume XVII Number 18
May 14, 1987

Photo Caption:
Hauling in the Hooligan – Jessie Palmer scoops up a net full of hooligan for a barbecue with friends Dave Gross, Maria Chambers and Maria's 2-year-old son, Frederick. The annual hooligan run drew seagulls and sea lions into Lutak Inlet as well as on-lookers who marveled at the spectacle of nature.

CVN 1988-0512

Volume XVIII Number 18
September 28, 2014

Eulachon run begins under flap of wings

Photo Caption:
Valley of the Seagulls – As many as 100,000 seagulls and artic terns, as well as hundreds of sea lions and a number of fisherman are converging on local rivers for the annual eulachon run. The run of the small fish started Monday and is expected to last about a week.

...fishermen with long-handled dipnets began gleaning the shallows of the Chilkoot and Chilkat rivers this week, scooping up their fill of the annual eulachon run.

The pursuit of the oil-rich fish – also known as "hooligan," "oolakan," and "candlefish" – is a springtime ritual for local Natives... It's also a feast for hundreds of sea lions and an almost imponderable number of seagulls and arctic terns.

The first wave of eulachon entered the rivers Monday and since then the birds have swarmed over those areas like flies over garbage...

Just how many birds are there? "That's a good question," said [Alaska Department of] Fish and Game biologist Ray Staska. "There's more than tons of thousands. I'd say there may be 100,000 this year. It's definitely a good year."

The birds come from parts of Southeast [Alaska] as far south as Sitka for the duration of the eulachon run, which Staska described as a virtual feeding frenzy.

The birds will be here perhaps a week, for the duration of the run and then move on. "They don't waste a whole lot of time," Staska said, adding that eagles also feed on the fish.

This week, residents were at upper Lutak Inlet and Carrs Cove, watching the birds as well as the sea lions, which Staska said sometime can be seen 30 to 40 at a time. "They come right up into the river." Like the birds, most of the sea lions will head out of the area when the eulachon run ends.

As for the [eulachon], they're expected to spawn and return for years to come. The 7 to 8-inch fish... spawn in the rivers in their third year. They live an average of four years.

CVN 1989-0504
Volume XIX Number 17
May 4, 1989

Nature's hum heralds a new season

Eagles, arctic terns and several species of gulls were gathering at the mouth of the Chilkat River this week, where the advent of the hooligan run marked the early days of summer.

[Alaska Department of] Fish and Game biologist Ray Staska said the run of candlefish on local rivers should come in about a week, attracting sea lions, seals and swarms of seagulls that... come from all parts of Southeast [Alaska] to feed.

CVN 1989-0608
June 8, 1989

Photo Caption:
Swarm of Seagulls – Some of the thousands of gulls here for the recent hooligan run take off over the Chilkat River flats along Mud Bay Road. Biologists estimate as many as 100,000 gulls congregate here to feed on the hooligan during the run. Tom Morphet photo.

CVN 1991-0516
Volume XXI Number 19
May 16, 1991

A harvest of eulachon, Darlene Obsharsky

Photo Caption:
Fred Philips of Juneau dip-nets eulachon on the Chilkoot River

Photo Caption:
Elmer Hotch fills his truck with eulachon.

"It was a good run, twice as good as last year," said Richard King, lifelong resident of Klukwan. The eulachon returned to both rivers, with the run at Chilkoot arriving a week later than the Chilkat run, he said.

The eulachon run signals the start of spring and provides one of the season's first sources of subsistence food...

Eulachon runs have been minimal on the Chilkoot side in recent years and diminishing on the Chilkat, King said.

State fisheries biologist Ray Staska attributes the good run this year to natural variations in the survival rate for eulachon fry.

"The people I talked to were happy (because) they were able to fill pits with what they needed to render oil," Staska said.

CVN 1992-0430
April 30, 1992

Photo Caption:

Sure Sign of Spring – Wayne Price scoops a net of eulachon at 4 Mile on Tuesday. The Chilkat run of the small, smelt-like fish appeared in strength Monday, and drew an enthusiastic crowd of local fisherman... The run also has attracted hundreds of thousands of gull and hundreds of marine mammals.

CVN 1993-0429
April 29, 1993

Unusual spawn of capelin a springtime treat for eagles

...eulachon expected to arrive in about a week.

CVN 1993-0527
Volume XXIII Number 20
May 27, 1993

In Klukwan, Lani Hotch

The eulachon season has come and gone and people have completed the process of rendering the oil.

It was not a very good run this year, most people would agree. Usually our family makes about eight gallons [of oil]; this year we made only one gallon.

Many people were busy... and were not able to fish, but even those who did did not get as much as usual.

CVN 1994-0512
May 12, 1994

In Klukwan, Lani Hotch

Photo Caption:
Hundreds of thousands of gulls have congregated along the Chilkat River to feast on a strong eulachon run.

The eulachon have made their spring run up into the Chilkat.

The river was stronger than it's been in years... Fishermen are still awaiting the Chilkoot return.

Fishermen were only catching a few [eulachon] at a time, but anticipating larger hauls with the evening's big tide.

[Jeff Klanott]... was doing very well, having already filled two large tubs and two five-gallon buckets in a half-hour.

The spring eulachon run is actually the second of the year. Some Natives still harvest a smaller run that arrives in February at 4 Mile.

CVN 1995-0511
Volume XXV Number 18
May 11, 1995

Photo Caption:
Sure Sign of Spring – Wayne Chambers dumps a load of eulachon into a fish tote after dipnetting on the Chilkoot River Monday. The annual run... moved into the Chilkoot Saturday, drawing subsistence fishermen, thousands of sea birds, and marine mammals. The run continued strong at mid-week.

CVN 1996-0502

May 2, 1996

Letters to the Editor

Restore traditional hooligan fishing, Tommy Jimmie, Daatkootsaakw

One of the first signs of spring is the return of the hooligan.

You may recollect last spring's hooligan run up the Chilkat River was virtually non-existent.

My grandfather used to refer to the first grove of hooligans as "the clean-up committee." These immature hooligan cleaned the rocks on which the mature female hooligan lay their eggs. The second grove included mature male and female hooligan who then entered the river to spawn.

You may also recall the extensive run of Chilkoot hooligan last spring. I believe a large portion of these hooligan should have gone up the Chilkat but bypassed the river instead.

CVN 1996-0509

Volume XXVI Number 18

May 9, 1996

Photo Caption:

Feeding Frenzy – Arctic terns and gulls wheel and dive for dinner at a pond along Mud Bay Road this week after eulachon were carried in on a weekend high tide. Eagles, whales and other sea life have also been sighted feeding on the spring bounty of Chilkat and Chilkoot inlets.

CVN 1996-0523

Volume XXVI Number 20

May 23, 1996

Photo Caption:

A Feast from the Deep – A group of sea lions surfaces and regroups while hunting eulachon at the mouth of the Chilkat River Saturday. The run also drew dozens of humans interested in getting their share of eulachon last weekend.

CVN 1998-0430
April 30, 1998

Hooligan sightings stall Chilkoot Dolly research

"We saw some early fish 'scouts,' we call them, were already up the river...," [Charles] Paddock said.

But a survey conducted Monday during a full tide cycle turned up no hooligan.

CVN 1999-0429
Volume XXIX Number 17
April 29, 1999

Herring return to Chilkoot

[Mark] Williams said the spring eulachon run typically comes immediately after the herring.

"(The herring) came in a little early this year," ...Williams said.

CVN 1999-0513
May 13, 1999

Photo Caption:

Harvest Time – The return of eulachon has drawn fishermen and wildlife to Chilkoot River. The run of oily fish... appears to have peaked last week... (Photos by John S. Hagen and Tom Morphet).

CVN 2000-0511
Volume XXX Number 19
May 11, 2000

Dinner on the Chilkoot

Photo Caption:
A sow brown bear with year-old triplets forage along the Chilkoot River, one of many species capitalizing on the annual eulachon run. Matt Davis photo.

Photo Caption:
Subsistence fishermen sort through buckets of eulachon at Chilkoot River while other try their luck with dip nets. Gulls, whales, sea lions and other marine life have gathered at Lutak to feast on the run of oily fish, long prized by the Tlingits for its medicinal and healthful properties. Tom Morphet photos.

CVN 2000-0518
May 18, 2000

Abundance, timing of eulachon a mystery, Micah True

Subsistence fishermen say this year's eulachon catch on the Chilkoot River was about average, but for the second consecutive year, none arrived in the Chilkat River.

[Eulachon's] springtime arrival, which attracts packs of sea lions, seals, occasional whales and tens of thousands of gulls, creates a wildlife spectacle...

Paul Wilson has fished for eulachon 20 years and used to net more than three pickup truckloads each year. Historically, the Chilkat run has been stronger than the one on the Chilkoot, he said...

[Joe] Hotch and other Natives blame major construction projects near the river for decreases in eulachon numbers. [Martha] Betts' report said Natives blamed road construction in the 1940s with a five-year lapse in the eulachon run on the Chilkat River.

Extending the airport several years ago and blasting near the river caused a dropoff in eulachon returns on the Chilkat, Hotch said.

Natives believe runs may appear short because the main school never enters the river after being alerted to danger by scouts.

"There were a few fish (on the Chilkoot side), but they never passed the weir. The few that went up I think were scouts," [Charlie] Jimmie [Sr.] said.

Independent research [Randy] Bachman conducted on his own time shows males tend to enter the Chilkoot River before females... "The bulk of the early fish that entered were males. Several days later, there was a good mixture of males and females."

This year's Chilkoot eulachon run came at the end of April and lasted less than a week.

CVN 2001-0426
Volume XXXI Number 16
April 16, 2001

Eulachon run comes in strong, unusually early, Jeff Goodhart

Flocks of gulls congregated. Packs of sea lions appeared...

Two words describe this year's [eulachon] run: It's early. But it also appeared especially robust. Besides arriving in harvestable volumes in both river systems, eulachon are being caught as far upriver as 6 Mile Haines Highway and Chilkoot River weir.

"It's really anyone's guess as to why the run is early this year," said Randy Fricksen, area sportfish management biologist. "Typically it happens during the first or second week of May."

The eulachon's sensitivity to water temperatures and a mild spring may have contributed to the early run, Ericksen said. Current and substrate size also play roles in when and where the run will take place, he said.

"I've never seen a run this early, not in the 70 years I've been doing this," said Evans Willard of Haines.

"I just can't figure it out," said Vincent Hotch of Klukwan, as he stood on the rocky bank of the Chilkoot River on a recent sunny afternoon. "Last year, I hardly got anything, but this year the run has been good. They're early this year though, just like everything else."

Ericksen, who has spoken to several fishermen, said the run on the Chilkoot was weaker than the run on the Chilkat. "Eulachon prefer sandy bottom to spawn in," he said. "The Chilkat's sandy substrate likely contributed to the stronger run there."

Fishing was slower for Christine Sweet of Klukwan. "I think it's because it's early," she said as she tossed her net into the Chilkoot, gently pulling it back toward her. "They usually come later."

CVN 2004-0429
Volume XXXIV Number 17
April 29, 2004

New twist on familiar traditions planned for eulachon season, Kristin Bigsby

At this time of year when Tommie Jimmie, Jr. was a young man, he often made his way to Chilkoot River to await the arrival of the eulachon. At the mouth of the river, he listened as seagulls screamed and sea lions barked, and watched as the marine creatures herded thousands of the up to 10-inch fish in the first feeding frenzy of spring.

Once, in the early 1970s, ...Jimmie and a few friends arrived at the Chilkoot to find a collection of Native and non-Native people on the riverbank scooping up eulachon. The fish hadn't traveled far enough up river to spawn, the traditional marker to begin dipping, he said.

"But the timing wasn't right. We knew if we disturb these fish right now, they'd decide not to go up the river and maybe not return," [Jimmie said].

Next week, or soon after, the eulachon should be ready for dipping along the Chilkat and Chilkoot rivers.

Both [Tommie Jimmie, Jr. and Phillip Jackson] have noticed a decrease in the size of the runs during their lifetimes.

[Tommie Jimmie, Jr. and Phillip Jackson] attribute the decline to increasing human activity in the rivers during the "critical" time the fish are migrating upriver.

"The seagulls are the ones who tell you they're here," Jackson said. "When you see the gulls on the flats near Pyramid Island, when you see them congregating, you know the eulachon are on their way. My dad always told me once they got past 1 Mile – Jones Point – that meant it was time to go dip for them. On the Chilkoot, you wanted to let them get as far as the culture camp."

Herring in the canal are another sign that the eulachon are coming, Jimmie said.

This week, residents were scooping up herring at Mud Bay.

The last few years have not been very productive, Jackson said. Runs have been diverted to Taiyasanka Harbor because of what he believes to be a "lack of respect for the fish."

"...It only happens once a year, between next week and the first two weeks of May... A long time ago, the run was so thick you could walk right across the Chilkoot. They used to run the whole month of May," Jackson said.

CVN 2006-0504
Volume XXXVI Number 7
May 4, 2006

Photo Caption:
Harvesting Eulachon – Jennifer Willard and Tina Olsen dump a tote of eulachon into the bed of a pickup truck Sunday night at the Chilkoot River. The run is the best in years. Photo by Matt Davis.

Eulachon run rushes in, Matt Hawthorne

The Chilkoot River was alive on Monday. The water rippled and a group of sea lions rushed to the surface, scattering a flock of gulls floating on the water.

"This is a really great run," said Tommy Jimmie, Jr.

Jimmie had already filled three larger coolers by mid-day... "It's been a long time since they've run like this. The last time I saw a run like this was as a little boy."

Jimmie said that his memory of big runs as a kid coincided with cold, stormy weather, much like this spring.

"We came out here at 3:30 in the morning for the high tide," explained the eighth-grader, [Kyle Rush].

It was a great morning for fishing, Rush said. "It's the best when they're everywhere, when the river is black with them. We'd fill our nets every cast and they were so heavy. It took two people to pull them out. We had people running buckets up the truck we were fishing."

Rush said he and his mom, Tammy Rush, and Scott Hotch filled a pick-up truck in less than three hours, then gave it all away to friends and family.

In the afternoon, [Rush] came back to catch fish for his family. The tide wasn't as high and he wasn't having as much luck, but he managed to fill the pick-up bed a quarter full.

CVN 2006-0511
Volume XXXVI Number 18
May 11, 2006

Photo Caption:
Spring Bounty – Victor Hotch unloads a net of squirming eulachon into a five-gallon bucket last week on the shore of the Chilkoot River. It wasn't long after the run began to subside that activity on the Chilkat River began to pick up. Photo by Matt Davis.

CVN 2009-0514
May 14, 2009

Photo Caption:
Season Spring Harvest – Don Hotch Jr. casts a throw net for eulachon last week near the Chilkoot River bridge. The smelt-like fish that Tlingits render for oil started running up

local rivers about May 5. Oil-rendering activities have started along the Chilkat River as well. Tom Morphet photo.

Chilkat Valley News, online digital format

CVN 2011-0505
May 5, 2011
Digital

Wild Things, Pam Randles

Seals, sea lions, and whales are chasing fish at the mouths of our rivers. Dozens of birds surround us – some residents, some summer migrants, and some newcomers.

Every year between late April and mid-May, eulachon and herring arrive to spawn in the Chilkat and Chilkoot Rivers. Eulachon arrived in the Chilkat April 23, a few days earlier than in recent years. Four days later, they were at Chilkoot. A smelt that is declining in the Pacific Northwest, eulachon look for sandy, rocky substrates with light water flow to lay their eggs.

Arriving about the same time, herring spawn mainly in Berner's Bay, but some come north to Mud Bay.

CVN 2011-0512
May 12, 2011

Count: 10 million Chilkoot eulachon, Tom Morphet

More than 10 million eulachon migrated past the Chilkoot River bridge, a return about five times the size of the one there last year, according to a study by Takshanuk Watershed Council and the Chilkoot Indian Association.

Watershed council executive director Brad Ryan said the study's numbers are preliminary but it was obvious the run was orders of magnitude larger than last year's.

"For a couple days, the river was running black with fish. You couldn't walk across the river without crushing them." Individual fish also appeared to be large, with some reaching nearly 10 inches in length, Ryan said.

The study is the first of its kind here on eulachon, a smelt-like fish that returns in surges annually to spawn in the Chilkoot and Chilkat rivers. The study is in its second and final year.

Researchers this year found that – in contrast to what some believe – eulachon spawn upstream of the riverside cultural camp, though only a few go into Chilkoot Lake, Ryan said. "Hundreds of thousands went past the culture camp. It's interesting they made it up there."

Also this year, sea lions and gulls didn't follow the fish upriver, but that may have been because of relative high abundance in the inlet, he said.

Eulachon fry spend only a few weeks in the river before washing back into the ocean. Wide fluctuation in eulachon returns from year to year may be due to occurrences at sea, as the fish spend very little time in fresh water, Ryan said.

"They're kind of a mystery fish. No research money has been spent looking into what ocean populations are doing. That's where the issues are with them," Ryan said.

Other questions include whether Chilkoot and Chilkat eulachon are distinct stocks. Recent genetic testing indicates the same stock returns to both rivers, but some area Natives believe otherwise, citing a difference in coloration.

According to previous research, eulachon, like salmon, die after spawning, but Ryan said he's skeptical of that. "You don't walk out there and find millions of dead eulachon. It would be interesting to confirm or disprove the spawn-and-die theory."

Researchers trapped about 49,000 fish at the Chilkoot River bridge, clipped an adipose fin, then resampled fish at upstream Chilkoot weir and arrived at the numeric estimate by comparing the ratio of clipped to unclipped fish.

Ryan said researchers have been unable to estimate the size of the return to the Chilkat River because they couldn't trap enough fish. Traps sank in mud there and the wide, braided river allowed fish to bypass them.

Comparing the size of the returns to each river would be difficult, he said. "There's such a size difference between them, I wouldn't have a clue."

Ryan said he may seek funding for a eulachon study next year with money from the tribe or through wildlife grants.

For about the past 10 years, Fish and Game commercial fisheries biologist Randy Bachman has taken a rough reading of the size of eulachon returns to local rivers. He rates the Chilkoot return as "really good" and the one up the Chilkat "above average."

Eulachon seemed to return in strong numbers throughout Southeast this year, including at Yakutat's Situk River and the Taiya River in Dyea, near Skagway, Bachman said. Bachman was chaperoning Juneau high school students last weekend who were impressed by eulachon numbers at Chilkoot. "They were wading in there, catching them with their bare hands. They had never seen anything like it.

CVN 2012-0426
Volume 42 Number 17
April 26, 2012

Wild Things: Nature in the Chilkat Valley, Pam Randles

> Herring and hooligan draw in many birds as well as sea mammals. A pod of orcas visited Lutak Inlet on April 18. The orcas are on the hunt for seals and sea lions. Harbor seals and Steller sea lions are fishing on both sides of the peninsula. Humpback whale sightings should be taking place more often as May progresses.

CVN 2012-0510
Volume XLII Number 19
May 10, 2012

> Photo Caption:
> Good Catch – A Bonaparte's gull scoops up a eulachon May 4 below the Chilkoot River bridge. The river's eulachon run appears larger than the 2.5 million fish return there two years ago, but smaller than the 12 million eulachon that returned last year, according to researcher Brad Ryan. Ron Horn photo.

CVN 2012-0517
Volume 42 Number 20
May 17, 2012

Birdathon' spotters count 77 species, Krista Kielsmeier

> Pam Randles, education coordinator for Takshanuk Watershed Council, said the eulachon run helped produce some unusual findings.
>
> "We had quite a few pelagic cormorants," Randles said. "They're usually out to sea, and they're usually farther out than here, but because the eulachon run was going, they came inland. This was on Pyramid Island, and at the same time, I saw an osprey, which we don't often see."

CVN 2012-0614
Volume 42, Number 24
June 14, 2012

Three-year eulachon study ends, Tom Morphet

The final year of a three-year study on eulachon runs in the Chilkat Valley documented an estimated return of 7.1 million of the smelt-like fish to the Chilkoot River.

The study, administered by Takshanuk Watershed Council for the Chilkoot Indian Association, is the first of its kind here on eulachon, a subsistence staple for Alaska Natives sometimes called "Tlingit penicillin."

No counts were done on the Chilkat River side, where the braided and silty nature of the river defeated attempted study methods.

"Hopefully we'll find some funding to keep the project going," said Luke Williams, environmental coordinator for the CIA. "Even if it's just clipping and counting to keep the data coming for some more years. We're still figuring it out."

The bulk of the Chilkoot run came in five days in early May, said biologist Brad Ryan, executive director of the watershed council. The tribe received a $200,000 grant for the work from the U.S. Fish and Wildlife Service.

This year's run on the Chilkoot compared to 12 million eulachon counted in 2011 and 2 million counted in 2010.

A few male eulachon went as far upstream as Chilkoot Lake, but most don't go further in freshwater than the site of the Chilkoot Culture Camp, about 100 yards downstream of the outlet of Chilkoot Lake. "The culture camp is basically the cutoff. It's amazing how

many fish go to the culture camp spot," Ryan said.

With the large run last year, about 40 males were found across Chilkoot Lake, at its inlet.

The study initially was aimed at gauging run size on Chilkat Inlet as well, but the braided nature of the Chilkat River made that impossible. Mark-recapture studies work by trapping, counting and marking fish downstream, then counting their relative abundance among fish upstream.

An alternate method of judging run size – by counting hatched fish leaving the river – also didn't work on the Chilkat because the river is too silty, the CIA's Williams said. "Our nets were filling up with silt."

Ryan characterized the study as the "beginning of a baseline" of knowledge about the fish.

Arriving at an "average" size for the run or a number necessary for escapement would take subsequent years of study, Ryan said. Eulachon fry return to fresh water between three and six years after hatching.

"The numbers are all over the board... There's a lot of holes left in the data," he said.

The study succeeded in getting initial information, developing a count method at Chilkoot and training tribal members in study techniques, Ryan said. It also employed "traditional ecological knowledge," the term for indigenous understandings about wildlife.

At Chilkoot, 49,000 fish were captured and clipped at Lutak bridge, and were recounted among numbers of fish caught by subsistence fishermen at the culture camp. Chilkoot knowledge of the run was critical to the study, Ryan said. "They had the location and timing dialed in."

One question that remains is whether Chilkoot and Chilkat eulachon are the same. Rob

Spangler, a Southcentral biologist who has researched eulachon populations here, says the Chilkoot and Chilkat fish are genetically identical. "Tlingits would tell you that's not true at all. They say you can tell by looking at (eulachon). One is bigger and darker than the other," Ryan said.

Continuation of the study is up to the tribe, which stands a better chance of receiving grant funding than the council, Ryan said. "It's a hard one to fund because eulachon aren't commercially viable fish. They're tremendously important to the Tlingit, but most people don't value them."

Ryan said purchase of traps, a boat and other equipment with initial grant funds should make the study less expensive in the future. Crews of up to a dozen workers a day are required to conduct the study, he said.

CVN 2013-0228
Volume 43 Number 8
February 8, 2013

Wild Things, Pam Randles

Spawning eulachon returned recently to the Chilkoot and Chilkat rivers. Native subsistence fishermen say the fish return here every year around this time, but often aren't noticed due to ice on the rivers. The winter run of the smelt-like fish was documented by Aurel and Arthur Krause in their visit here in the 1880s. Fish and Game biologists who measured ones caught in recent weeks found the fish to be about three-fourths the size of ones harvested in May. Henry Strong of Klukwan said they tasted just fine.

CVN 2013-0404
Volume 43 Number 13
April 4, 2013

Wild Things, Pam Randles

The orcas are likely transient rather than resident ones. Residents tend to hunt in pods for fish. Transient orcas – the ones common to this area – are typically solitary and hunt sea mammals. Orcas often are seen here in spring, hunting sea lions and seals that feed on herring, hooligan and such "forage" fish.

CVN 2013-0509
Volume XLIII Number 18
May 9, 2013

Photo Caption:
A Bonaparte's gull, left, drops a eulachon, while another watches the stray fish above Chilkoot River near the Lutak Bridge Monday morning. Eulachon started running late last week. Ron Horn photo.

Photo Caption:
Big Catch – Austin Davis, 14, of Haines hauls in a throw net full of eulachon Sunday near the Lutak bridge. Runs have attracted humpback whales and dozens of sea lions into Lutak Inlet. High harvests of fish for processing were reported. Ed Baker photo.

Duly Noted, Sara Callaghan Chapell

Tim June arrived in Haines Sunday, in time to catch the return of the spring eulachon run.

CVN 2013-0523
Volume 43, Number 20
May 23, 2013

Wild Things,Pam Randles

The hooligan and herring arrived to spawn right on time in the first week of May. These fish attract copious numbers of predators. Literally tens of thousands of gulls arrive to wheel and squeal alongside dozens of eagles and Steller sea lions.

CVN 2013-0530
Volume 43 Number 21
May 30, 2013

Fishermen process surplus of eulachon, Karen Garcia

Tlingit fishermen say the recent eulachon run harvest was robust enough to provide subsistence needs for another year.

On Friday, May 17, Alden Paddock and Richard Warren stood around their respective vats full of nearly-boiling water and rancid fish carcasses, carefully nursing the mixtures for hours on end in order to produce the desired result: gallons of eulachon oil to be consumed locally and traded all over the country.

CVN 2014-0501
Volume 44 Number 17
May 1, 2014

Wild Things, Pam Randles

The annual herring run in Mud Bay started in earnest Sunday, with residents using canoes, driftnets and throw nets to haul in buckets full of the silvery fish. As many as 10 eagles and flocks of hundreds of gulls were there feasting on the bounty. Eulachon can't be far behind.

The sea lions come searching for forage fish such as herring, eulachon, and capelin.

Orcas come stalking sea lions and seals.

CVN 2014-0508
Volume XLIV Number 18
May 8, 2014

Photo Caption:
Mud Bay Harvest – Eulachon showed up in Chilkoot and Chilkat rivers this week. Tom Morphet photos.

CVN 2014-0522
Volume 44, Number 20
May 22, 2014

Chilkoot eulachon run estimated at 3.4 million

An estimated 3.4 million eulachon returned to Chilkoot River May 5-9, according to research by Takshanuk Watershed Council and the Chilkoot Indian Association.

Four years of research show the size of the run as average or a bit smaller than in previous years. Previous counts found 12.6 million of the smelt-like fish in 2011, 2.2 million in 2010 and 7.1 million in 2012. For lack of grant funding, a count wasn't made in 2013, according to Meredith Pochardt of the watershed council.

Nine workers in two crews used a trap and recapture method, with stations at Chilkoot River bridge and Chilkoot weir, to develop the estimate, which is accurate to plus or minus 500,000 fish, Pochardt said.

Eulachon spawn in the river. "Most Tlingits believe they spawn near the (Chilkoot) culture camp," Pochardt said.

Subsistence fishermen seemed to get the fish they needed during the peak of the run, she said. Eulachon are prepared a variety of ways, including drying and smoking. They're an important part of the Tlingit diet, with apparent health benefits. Natives age tons of the fish in pits, rendering their oil, which is used as a condiment on traditional foods.

Fish and Game biologist Randy Bachman has kept informal tabs on the runs of eulachon on the Chilkoot and Chilkat rivers. (The braided nature of the Chilkat River precludes a scientific mark-recapture count there.)

Bachman said volumes of eulachon appeared to have arrived in Chilkat Inlet near Pyramid Island about a day after they showed up at Chilkoot. "They're kind of on the west side (of the inlet). Just looking, I'd say (the run) is a little better than average on the Chilkat side, just based on my own observations and conversation from people."

In some years, eulachon don't show on the Chilkoot River, but they seem to always return to the Chilkat, Bachman said. Eulachon sometimes return to Skagway's Taiya River, he said, and those returns have sometime coincided with absence of eulachon on the Chilkoot, he said.

Lynn Canal News (LCN)
Serving the communities of Haines, Klukwan and Skagway, Alaska from 1979 to 1984.

LCN 1981-0514
Volume III Number 11
May 14, 1981

Hooligan – a fish with many names and uses, Sharon Resnick

...the fish travel anywhere from 25 to 35 miles a day and appear to leave as fast as they come.

If the small fish don't catch your eye to let you know they arrived, the noise of the sea lions, seals and gulls in pursuit of it are bound to catch your ear.

LCN 1982-0520
Volume IV Number 19
May 20, 1982

Photo Caption:
Last week found halibut fishers at sea and hooligan fishers on the banks of the Chilkoot River. – Photo by Sharon Resnick

LCN 1984-0419
April 19, 1984

Treasures from the deep have many forms, Alys Culhane

The word is the "Thaleichthys pacificus" are already beginning to make their way up the Chilkat River.... the eulachon or hooligan are running.

When [eulachon] start appearing the second week of May in the Chilkat, and a few weeks later in the Chilkoot, they are in treacherous waters.

If they are not eaten by eagles, artic terns, gulls or other sea birds...

The hooligan are netted by individuals who fish for them. They use long-handled dip nets along the shallows of the river, close to the highway. The hooligan are then smoked or used for oil.

If they survive, [eulachon] can make the journey from the sea upriver and back seven or eight times.

Tlingit Austin Hammond said the hooligans start running "when the big tide comes in."

The Natives fish hooligan from the banks of the Chilkat first. After they dip-net the fish, they let them sit for ten days in a pit. This ripens the fish and releases the oil. The grease is then heated. The process is then repeated on the Chilkoot River.

Eagle Eye Journal (EEJ)
Serving Lynn Canal and Chilkat Valley

EEJ 2000-0504
Volume IV Number 18
May 4, 2000

Photo Caption:
Nothing But Net... and Hooligan! Bucking the current, Phil Kattenhorn reaps from the cold waters of the Chilkoot, near the river's mouth. The annual run of eulachon brought out in force co-competitors like sea lions, orcas, porpoises, eagles and the ubiquitous sea gull. (Kris Reeves)

Dinner Bell Along the Chilkoot – Hooligan Return, Kevin Reeves

If the congregation of sea lions in Lukak Inlet is any indication, the time of year looked forward to many Native people has arrived. The massive pinnipeds... Seagulls...

...the eulachon has once again fought its way up the Lynn Canal and to the Chilkoot River through... seagulls, porpoises, sea lions and the inevitable fisherman.

The annual run of eulachon... initially appears strong in the Lutak area. The fish normally run up both major rivers in the Haines area, sometimes at different intervals, but it's possible... that the Chilkat River may see little or no action this year due to apparent low water levels. It would be the second year in a row for a poor showing at the Chilkat River.

A once-a-year event lasting only about a week...

Appendix F

Eulachon run timing and abundance observations in the Chilkat-Chilkoot area

Observations were integrated from LTK, newspapers, and literature to chronologically describe run timing and abundance records by year or time period. Full bibliographic information for the sources cited here is found in Chapter 7, Literature Cited, with the exception of information from newspapers. In this case, sources are identified by a three-letter, eight-digit code where the first three letters identify the newspaper (e.g., LCN = Lynn Canal News; CVN = Chilkat Valley News), the next four digits indicate the year of publication, and the final four digits indicate the two-digit month and two-digit day of publication.

Time Period	Observations
1940s	• Betts (1994) reported that eulachon runs were absent from the Chilkat River for five years, following highway construction that occurred in the 1940s.
1970s	• A respondent described that in the 1970s, eulachon were seined one year. He described the following year to be a normal run, but for several years after, harvest numbers were low.
1981	• By May 14, the local eulachon run had passed (LCN 1981-0514).
1982	• Both the Chilkat and Chilkoot river runs occurred in mid-May (LCN 1982-0520; Mills 1982).
1984	• Chilkat River eulachon run was observed on April 19 (LCN 1984-0419).
1985	• The Chilkat River run was in mid- to early May (CVN 1985-0516), and the Chilkoot River run started around May 10.
1986	• Eulachon were observed in the Chilkoot River on May 10.
1987	• The Chilkoot River eulachon run was observed on May 3; CVN 1987-0514 reported that eulachon ran before May 14.
1988	• Eulachon ran up the Chilkat River in mid-May, during the week of May 12 (CVN 1988-0512; Magdanz 1988); the Chilkoot River eulachon run was observed to start on May 7 and also reported during the week of May 12 (CVN 1988-0512). • The eulachon run was described as a good year, as hundreds of sea lions and thousands of birds, including gulls and arctic terns, were present for the run

	(CVN 1988-0512).
1989	• The Chilkat River eulachon run occurred between May 4 (CVN 1989-0504) and June 6 (CVN 1989-0608); the newspaper expected the run to arrive approximately around May 11 (CVN 1989-0504). • Eulachon of the Chilkat River migrated, spawned, and died within the lower eight miles of the river (Bishop et al. 1989). Bishop et al. (1989) observed that the relatively early run in 1989 corresponded with high tides of 18-20 feet. • Eulachon on the south side of the Chilkat River had been observed as increasing in recent years, as well as gradual shifts of river channels (Bishop et al. 1989).
Late 1980s	• Eulachon of the Chilkat and Chilkoot rivers were perceived as declining since the late 1980s and attributed to rule-breaking or lack of adherence to Tlingit rules of harvesting (Betts 1994). • It was reported that a former fishing spot along the Chilkat River, at 7-mile, had "run dry" of eulachon in recent years of 1990 (CVN 1990-0309).
1990	• Research was initiated to respond to local concerns of eulachon abundance of the Chilkat and Chilkoot rivers, including a perceived decline and potential impacts to the Chilkat River eulachon run from modifications to the Haines airport (Betts 1994). The Haines airport is located along the Chilkat River and was expanded in the fall and winter of 1990 and 1991 (Betts 1994). The Chilkat River run of 1990 was noted to start on May 1 and end on May 7 (Betts 1994). • The Chilkoot River was noted to start on May 6 (LTK 19; Betts 1994) and also observed on May 9 (Betts 1994). • However, in 1990, eulachon arrived two weeks prior to the highest tides (Bishop et al. 1989).
1991	• Eulachon were observed as early as May 6 in the Chilkat River and as late as May 16 (CVN 1991-0516; Betts 1994). • The Chilkoot River run of 1991 reported to start on May 8 (LTK 19) and May 9 and observed up to May 16 (Betts 1994).

	• The eulachon run of 1991 was described as a good run and twice as good as the previous year run in 1990 (CVN 1991-0516). This was attributed to natural variations in survival rates of eulachon fry (CVN 1991-0516). Harvesters were able to fill their pits with enough eulachon to render oil (CVN 1991-0516). However, eulachon runs had been described as minimal on the Chilkoot River and diminishing on the Chilkat River in recent years (CVN 1991-0516). • In 1991, eulachon migrated up the Chilkat River a number of days prior to the highest tides in May, but the Chilkoot River eulachon migrated upriver during high tides (Bishop et al. 1989).
1992	• Eulachon were running in the Chilkat River on April 27 and April 28 (CVN 1992-0430); the Chilkoot River run of 1992 was reported to start on May 2. The start of the Chilkat River eulachon run in 1992 appeared strong, and hundreds of thousands of gulls and hundreds of marine mammals were observed (CVN 1992-0430).
1993	• The Chilkoot River had not arrived by May 12 and perhaps not at all. 1993 was noted to be not a very good run (CVN 1993-0527); where one family was said to normally produce eight gallons of oil, only one gallon was produced in 1993 (CVN 1993-0527).
1994	• The Chilkat River run occurred prior to May 12 (CVN 1994-0512); and the Chilkoot River run had not occurred by May 12 (CVN 1994-0512) but was first observed on May 13. In 1994, the Chilkat River eulachon was considered strong, and hundreds of thousands of gulls were observed eating eulachon along the river (CVN 1994-0512). This run was described and stronger than it had been in previous years, and people had recently feared that changes to the river could jeopardize harvests (CVN 1994-0512). Harvest quantities increased throughout the day and were considered strong; at 4-Mile, fishermen only caught a few eulachon at a time but expected larger quantities near the big tide later that evening (CVN 1994-0512). At 6-Mile later in the day, a harvester had already filled two large tubs and two five-gallon buckets

	within a half hour; an hour later, harvesters had filled all their containers and two pickup trucks bed (CVN 1994-0512).
1995	• The Chilkoot River run started around May 5 (LTK 19) and May 6 and observed up to May 10 (CVN 1995-0511). • 1995 was described as strong with the presence of marine mammals and thousands of sea birds (CVN 1995-0511); the Chilkoot River run, specifically, was described as extensive that year (CVN 1996-0502).
1996	• Eulachon reportedly ran up the Chilkat River during a weekend high tide around May 4 or May 5 (CVN 1996-0509). • The Chilkoot River run started on May 15 (LTK 19) and was also observed on May 18 (CVN 1996-0523). • However, the Chilkat River eulachon run was described as "virtually non-existent" (CVN 1996-0502). • From the mid to late 1990s, a respondent started noticing less eulachon.
1998	• The Chilkoot run of 1998 had not arrived by April 27 (CVN 1998-0430) but was first observed on April 29 (LTK 19).
1999	• In 1999, the Chilkoot run was first observed on May 3. In 1999, the Chilkat River run was considered weak (EEJ 2000-0504) or non-existent (CVN 2000-0518).
1999 to 2004	• A respondent described that there was a time period between approximately 1999 and 2004, where low abundance of eulachon caused people to become concerned; he described that a couple of people in the community discouraged others from harvesting eulachon.
2000	• The runs in initially appeared strong in early May, but some people predicted the Chilkat River run would be weak due to apparent low water levels, which would be the second year of poor runs on the Chilkat River (EEJ 2000-0504). • In mid-May of 2000, it was reported that, for the second consecutive year, no eulachon runs were in the Chilkat River (CVN 2000-0518). • The Chilkoot River run was considered average (CVN 2000-0518).
2001	• The runs were considered strong and robust (CVN 2001-0426). According to

	a newspaper article, eulachon runs were of harvestable abundances in both the Chilkat and Chilkoot rivers (CVN 2001-0426). • In the Chilkat River, eulachon were harvested as far upriver as 6 Mile Haines Highway and to the weir in the Chilkoot River; some people considered the Chilkat run to be stronger than the Chilkoot (CVN 2001-0426). • In addition, eulachon were considered early, and harvesting was slow (CVN 2001-0426).
2005	• A respondent described that the Chilkoot River run was black with eulachon, extending from the intertidal zone to just downriver of the lake; he said this was the highest abundance he had observed there. He thought the Chilkat River run was average. • A respondent described that there were no eulachon in 2005 or 2006, but years before that were average.
2006	• The run was described as a great run; including someone reporting that it was best run in years; he reported that he had not seen a run this good since he was a child (CVN 2006-0504). This person said that his memories of large runs as a child coincided with cold, rainy weather, similar to the spring weather of 2006 (CVN 2006-0504). Another person described his harvesting experience, beginning at 3:30am for the high tide (CVN 2006-0504). He said that the morning harvests were great, and each cast produced a full net that required two people's strength to pull it out; with three people, a pick-up truck bed was full in less than three hours (CVN 2006-0504). When he returned in the afternoon, the tide was lower and harvests were not as high but enough to fill a truck bed a quarter full (CVN 2006-0504). • A respondent described that there were no eulachon in 2005 or 2006, but years before that were average. • A respondent that thought the Chilkat River run was a really good run that lasted a week.
2007	• A respondent noted that there were barely any eulachon in approximately 2007.

2008	• A respondent noted that, in 2008 or 2009, the eulachon run was small and absent of gulls on both rivers.
2009	• A respondent noted that, in 2008 or 2009, the eulachon run was small and absent of gulls on both rivers.
2009 to 2013	• Between approximately 2009 and 2013, a respondent started to notice that eulachon abundance was lower near the Haines Airport along the Chilkat River, and he thought that construction had impacted the river. He also said that eulachon appeared to be present along the west side of the river but that this is difficult to verify, due to difficulty and dangers traveling to that side of the river.
2010	• In approximately 2010, according to a respondent, there were so many eulachon that they came into the golf course during a tide. The newspaper reported that eulachon returned in abundance to the area, which had been rare in recent years (CVN 2010-1206). • In 2010, the eulachon run of the Chilkoot River was estimated to be 2.2 million eulachon (Ryan 2012).
2011	• Eulachon seemed to return in strong numbers throughout Southeast Alaska (CVN 2011-0512). More than 10 million eulachon migrated up the Chilkoot River, about five times as abundant as the 2010 Chilkoot River run (CVN 2011-0512). • A study estimated the Chilkoot River run to be 12.6 million eulachon (Ryan 2012). For a couple of days, the Chilkoot River was described as running black with eulachon; fish appeared large, including some nearly ten inches in length (CVN 2011-0512). • The run was also described to be so large that eulachon traveled passed the Chilkoot Lake, a surprising occurrence; the newspaper reported that about forty male eulachon were found across the Chilkoot Lake (CVN 2012-0614). • A local resident who informally monitors eulachon abundance in the local area described the Chilkoot River run as "really good" and the Chilkat River run "above average" (CVN 2011-0512).

2012	• Eulachon runs were considered good. The abundance of the Chilkoot River run was estimated to be 7.1 million eulachon (Ryan 2012). • One respondent said that both the Chilkat and Chilkoot River runs were the largest he had seen in twenty years. • Another respondent agreed that the runs were good but especially strong on the Chilkoot River; he also said he has not seen an abundance of eulachon this large in many years. He described that people stopped preparing eulachon camps because the runs could not be relied on, as people did not catch any eulachon for two years. • A newspaper article reported that the Chilkoot River run of 2012 appeared larger that the run in 2010, estimated to be 2.5 million fish, and smaller than the 2011 run of twelve million eulachon (CVN 2012-0510). • The large runs were also noted to attract pelagic cormorants on Pyramid Island; it was described that they are usually at sea but came inland for the eulachon run (CVN 2012-0614).
2013	• A respondent said that the runs were good, but another respondent said that, based on general observations, the abundance appeared average. • High harvests of eulachon were reported, enough for processing and to provide subsistence resources for another year (CVN 2013-0509; CVN 2013-0530). • Eulachon were also caught in February, and biologists described them to be about three-quarters the size of eulachon that are harvested in May (CVN 2013-0228).
2014	• The Chilkoot River run was estimated to be 3.4 million; from four years of recent research, 2014 would be considered average or a bit smaller than previous years (CVN 2011-0512). • Subsistence harvesters appeared to obtain the quantity they needed during the peak of the run (CVN 2011-0512). • According to a local resident, the run seemed a little better than average (CVN 2011-0512).